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Friday, February 19, 1892.

LIEUTENANT-GENERAL THE HON. W. H. A. FEILDING, Inspector-General of Recruiting, in the Chair.

THE TELEPHONE AT HOME AND IN THE FIELD.

By Major C. F. C. BERESFORD, R.E.

THE discoveries of science that are crowding up the close of the nineteenth century have elbowed the telephone out of the company of novelties, and reduced it to the level of the common-place, found wherever men are busy, and where economy in time and labour is a consideration.

There is, always has been, and possibly always will be, a certain prejudice in favour of the human voice as the medium for intercommunication, but, till within the last decade, distance had, perhaps happily, limited its sphere of action, and that, in spite of the efforts dating from the darkest ages which have constantly been made to supplement the power of speech.

Written signs sent by messenger, visual signals, acoustic signals, the electric telegraph, all have had their turn, but the instantaneous transmission of sounds and spoken words, over distances measured in miles and hundreds of miles, has been reserved for our day.

There may be drawbacks to the discovery, for however well established the fact may be that the more perfect the means of communication, so the greater are the chances of success in any operation of peace or war, it is not so well established that the human voice is, under all circumstances, the medium most to be desired for arriving at a satisfactory result. Experience, in fact, may have taught some of us that any contrivance for transmitting the voice itself might very easily pass from a blessing into a curse, and that, while considering to what use we could put the telephone, we should not shut our eyes to its possible abuse.

Origin.

The telephone may be said to have been invented in 1876, by an American gentleman, Professor Graham Bell.

In 1877 Mr. Preece, well known to all of us as the author of the latest telephonic triumph, the London-Paris Telephone Line, having been to America, brought back some of the instruments, and, in the same year, exhibited them to the Officers of the Telegraph Troop, in the R.E. Theatre at Aldershot.

This was the birth of the military telephone.

General Description.

It was then in its simplest form, namely, a straight, permanent magnet, on one pole of which was fixed a coil of wire, with a soft iron core, and a mouth-piece fitted with a thin iron diaphragm.

No battery was used, and the instrument served for both sending and receiving.

In this form it gave feeble results, and was at first considered as little more than a toy, not of value for military purposes.

This first opinion had reference to its "talking" powers and not as a transmitter and receiver of Morse signals, in which line, to some at least, it gave promise of future success.

The Microphone.

Following close upon the telephone came the great invention of Professor Hughes, which at once opened the door to its practical employment. This was the microphone.

The microphones with which we have to do in the Service consist of pieces of carbon placed in loose contact in the circuit. The vibrations of the carbon caused by the voice produce corresponding variations in the current of a battery attached, and the loudness of the transmitted sounds depends on the amount of these variations.

A small battery is a necessary adjunct of a microphone.

"Calling" Apparatus.

In addition to the telephone and microphone, we also require a means of calling the attention of those at the distant end of a line. There are various ways of doing this. But in dealing with military movable telephone systems, the chief difficulty is to devise an efficient "call" apparatus which will not involve the use of a battery or any bulky or delicate machinery.

The call may be made either by bells, by a vibrating sounder, or by the reproduction of various sounds in the distant telephone, using for the purpose, reeds, whistles, or vibrating instruments.

The bell is the appliance which gives the most distinct call, but it requires either considerable battery power or a magneto machine to ring it.

The reed is independent of extra power, but its sound, received on the distant telephone, is comparatively feeble.

A telephone installation complete thus consists of three distinct and principal parts, *i.e.*, the telephone proper, the microphone with its battery, and the calling apparatus.

Its development in England was long delayed by the fact that the patent rights were all in the hands of one company, but, now that these rights have mostly expired, we may hope for rapid improvements and simplifications both in the instruments themselves and in the methods of using them. This view of the matter is of special importance to the growth of Army telegraphy, where simplicity for the soldier and economy for the exchequer are the two things needful.

The telephone, in its complete form with microphone and call apparatus, is a more or less delicate instrument, and requires an intimate acquaintance with its idiosyncrasies to keep it in good working order.

If we propose to extend the telephone for field service, and introduce it as an article for general use in the hands of the soldier, some simpler form is necessary; in fact, we may not hope to introduce any such apparatus which does not combine extreme simplicity with extreme cheapness.

Specimens of Instruments.

The following are some specimens of the instruments and appurtenances at present available in the military Service:—

1. A telephone in its original simple form.
2. The "Ader" telephone, transmitter, and receiver.
3. The "Ader" receiver combined with a vibrator.
4. The "Ader" receiver combined with a Morse key.
5. The "Berthon" transmitter.
6. The "Operators" telephone.
7. The "Gower-Bell" telephone.
8. The "The Siemens-Halske" telephone, with "reed" call.
9. The "Aubry" telephone (French Service).
10. A "trembling bell."
11. A "magneto call."
12. "Exchange" switch.

The "Ader" receiver, which is a modification of the telephone in its simplest form, can be used without a microphone, on short lines, as a speaking instrument, but is only of very moderate power when so used.

Its great value, however, appears when in combination with the instrument familiarly known as the "vibrating sounder," or "buzzer," a system, introduced some years ago by Major Cardew, which enables communication to be held under circumstances when every other form of telegraph would fail; by its means signals can be sent through bare wire lying on the ground, and even in water, while in India some successful experiments have, by its aid, been carried out in telegraphing without connecting wires across rivers.

The "buzzer" may be called the backbone of British field telegraphy. When a microphone is added, the combination can then be used at will for speaking, or for communication by Morse signals.

The "receiver" used in connection with a Morse key is, perhaps, the simplest form of all telegraphic apparatus; it was tried some years ago at Chatham, but difficulties were experienced in reading, on account of the make-and-break "clicks" being so similar in sound.

Late experiments at Aldershot have, however, shown that this difficulty is got over, and signals have been read with ease through a resistance of 4,000 ohms, and through field cable circuits, using only one field service battery cell, such as might be carried in a man's pouch.

The "Ader" apparatus complete, *i.e.*, telephone and microphone, is one of the best at present existing for speaking purposes. It has given excellent results during the last year at Aldershot for work between the various temporary camps, on the New Ash ranges, and on the "Exchange" systems during the manœuvres. It is not so portable as the "Operators" telephone, but speaks louder.

The "Berthon" microphone, or "transmitter," in which the carbon takes the shape of small pellets between two plates of the same substance, is of a very portable form, and is also useful for telephones in forts where the firing of heavy guns is apt to break the carbon pencils in the other pattern of microphones.

The "Operators" telephone is a combination of the "Berthon" microphone and the "Ader" receiver, these two being fixed to one handle.

The "Gower-Bell" telephone is, perhaps, the most powerful instrument of all; it is that used by the General Post Office, but its size prohibits its use as a field instrument.

The "Siemens-Halske" pattern has been a good deal used in foreign armies, and is at present in use with our balloon service, though it will, no doubt, be superseded by the "Operators" telephone.

The "Aubry" telephone, from our experiments at Aldershot, appears to give as good, if not better results than the "Ader" receiver. It is the pattern of receiver used in the French Army.

The principal method hitherto adopted of calling a distant station is the "bell" rung by battery power. This is inconvenient for military purposes in the field, owing to the size of the battery necessary, and the "magneto call" will be adopted for telephone stations.

Calls can also be effected by means of the vibrating sounder, or by the use of reeds, as in the "Siemens-Halske" instrument. The "reed" form of call, being the simplest, would seem to be that most suitable, if sufficiently audible, for the future development of telephones for outpost work, and where distances are short Morse signals can be transmitted by reed, as by key or "buzzer." Considering, however, the comparative feebleness of the calls, some contrivance for fixing the telephone against the ear might be found desirable.

"Exchange" Telephone Switch.

The switch used last year during the manœuvres was of the G.P.O. pattern, but the new form arranged by Major Bagnold is that sealed for use in the Service.

The Post Office pattern has the advantage of being more compact, and of being fitted for double wires; Major Bagnold's switch, that of dispensing with the connecting cords for the pegs.

To give a telephone fair play, double wires are often necessary, especially when vibrators are in the neighbourhood, or when the wires of the circuit run on the same poles as those of other circuits.

Under this consideration, I consider it very doubtful whether the G.P.O. pattern would not be the most serviceable in the field. No disadvantage has as yet been found in the use of the cords connecting the pegs, the absence of these being claimed as the chief advantage of the other forms.

Methods of Using the Telephone.

The telephone can be used in two ways for carrying on communication—

(1.) As a talking instrument, with or without a microphone.
(2.) As a receiver or transmitter of Morse signals.

Even the best telephones are not, as yet, perfect mediums for speech. The clearness with which words are reproduced depends to a great extent on the quality of the speaker's voice, if not also on the quality of the listener's ear. The softer or sibilant sounds are transmitted with difficulty, causing delays and errors in messages, and telephone circuits are peculiarly affected by disturbing influences, such as are produced by neighbouring telegraph circuits and earth currents.

Morse signals are transmitted with much greater certainty and accuracy by telephone than are spoken words, and I venture to predict that it is in this direction that one of the chief developments of the telephone for military purposes is to be looked for in the future.

The Morse signals can be produced in the following ways:—

(1.) By the simple making and breaking of a current by a key.
(2.) By series of vibratory currents sent by the key of a vibrating sounder.
(3.) By series of sounds with Morse intervals, such as can be produced by reeds, whistles, or the voice.

All that is required is the general training of men to read Morse signals.

Comparison of the Telephone with Telegraph Instruments as a Means of Communication.

It might appear at first sight that, in matter of pace, a telephone used for speaking had great advantage over one used for Morse

signals, or over a telegraph instrument. But practically for written messages the pace is limited to the writing pace of the receiving clerk.

We know that forty words per minute is practically the utmost limit for first-class receiving on a sounder, hand-speed, circuit.

The Wheatstone fast-speed instrument used in the Post Office has certainly an output of 300 or 400 words per minute, but then it is fed at the sending end by a number of men, the individual work of whom, being taken into consideration, would not exceed forty words per minute per man employed. Forty words per minute is also the practical limit of pace in writing out a message, and thirty, or even twenty-five, would probably represent the average.

Now the human voice could send a message at the rate of from 150 to 200 words per minute, but although this might possibly be received on a good telephone, it could not be written down except by shorthand. We cannot, as yet, say how far the phonograph may help us for recording telephonic messages, but the phonograph could scarcely enter into consideration for universal use in the field.

Further than this, the telephone at present does not carry the voice so distinctly as to make it reliable for quick work.

From practical experience at Aldershot, when in some of the Divisional Offices both telegraph and telephone are working side by side, there is no doubt of the great superiority of the sounder over the telephone circuits for carrying traffic.

On the other hand, the telephone circuits require little or no special qualifications for the clerks employed, while, for the military sounder clerks, picked men and a training of from four to six or nine months are necessary even for 2nd class offices.

From the foregoing it appears that the following, if brought about, would be a way of increasing the carrying power of ordinary telegraph lines, perhaps up to five times:—

(1.) Improved telephones.
(2.) A more wide-spread instruction in shorthand writing.

The first we may look upon as a future certainty, the second as a matter of elementary education.

At the present time the instruction of shorthand is on the increase, and such are its uses that we may hope one day to see it taught in every school.

Pending these suggested improvements we must pin our faith on Morse signals for the more important work.

The reading of these is very easily attained by children and boys up to the age of eighteen, and, as the Service at present is not altogether without the latter, there would not seem to be any insuperable difficulty in obtaining a sufficient number of Morse clerks; and it is to be remembered that the telephone, as a Morse receiver, is a far more sensitive, economical, and simple apparatus than any telegraph instrument in use.

The telephone, as a speaking instrument, in its present state, rather more suited for conversation than for the transmission of im-

portant military orders; at any rate in the field. Its importance in this respect is most marked under circumstances where queries on minor details demand immediate replies, as is the case in local transactions with our supply services; and here comes in the advantage of a telephone exchange.

But for use on the main line of communication, or for outpost duty, except under exceptional circumstances, the effective use of the telephone for speaking is doubtful.

When and Where to Employ the Telephone (for speaking).

Having seen what telephonic appliances are available, what is to be expected and what is not to be expected from the telephone, attention may be next directed to the consideration of circumstances under which it can be profitably employed for Army purposes.

These may be generalized under the following headings:—

(1.) Telephones and exchanges in garrisons.
(2.) For coast defence, including artillery, submarine mining, and general purposes.
(3.) On rifle ranges.
(4.) On artillery ranges.
(5.) For siege operations.
(6.) Main lines of communication in the field.
(7.) Intercommunication in camps.
(8.) Outpost duties.

In Garrisons.

For garrison work the use of the telephone is obvious; it is employed at all our garrisons and dockyards at the present moment, and its great extension merely a matter of time.

For Coast Defence.

Having had no personal experience of the telephone for coast defence, I hope some of the Officers here will give us their views as to its present use, future development, and forms of apparatus most suitable.

On Rifle Ranges.

During the spring of 1891, telephone lines were erected along the three new rifle ranges at Ash, near Aldershot; the instruments used up to the present time are "Aders" (transmitters and receivers); these, as I learn from the Inspector of Musketry, Major Crabbe, have given such good results that the extension of the system to all ranges may be confidently looked for.

On each range the circuits run from the butts to various firing points, and each range is also in connection with the caretaker's hut and with the camp at Aldershot.

The movable instruments and batteries are fixed in a species of

sedan chair, which is carried from firing point to firing point as required.

For Siege Operations.

Colonel Lyons, the Commandant at Lydd, has made a series of valuable experiments with various forms of telephones for use in directing artillery fire at siege operations, and for observing and plotting results.

He has come to the conclusion that the telephone as a talking instrument is not reliable for this purpose, but that when in combination with the vibrating sounder it does excellent work. This, however, necessitates the employment of trained sounder clerks.

For Main Lines of Communication.

For work on main lines of communication the telephone, as a talking instrument, would not be of much service. In the first place, it would not carry the traffic which we are accustomed to, and, to give it fair play, it should be served by a well-insulated line, with double wires if on the same poles as other lines. These conditions are frequently impossible on long field lines.

At the same time, occasions would often arise when it might be desirable for Commanders in the field to hold direct communication by telephone, and arrangements for accomplishing this at will should always be made.

The Belgian system, introduced by Major Waffelaert, admits of a telephone and telegraph instrument being used simultaneously on the same circuit, without interfering with each other.

We have in the British Army an appliance known as a "separator" which accomplishes the same purpose, but it has not, as yet, come into general use, although it has a promising future before it.

As an example of what the telephone may be expected to do on a long field line, I may mention the experiments carried out during the summer exercise of the 1st division Telegraph Battalion last year.

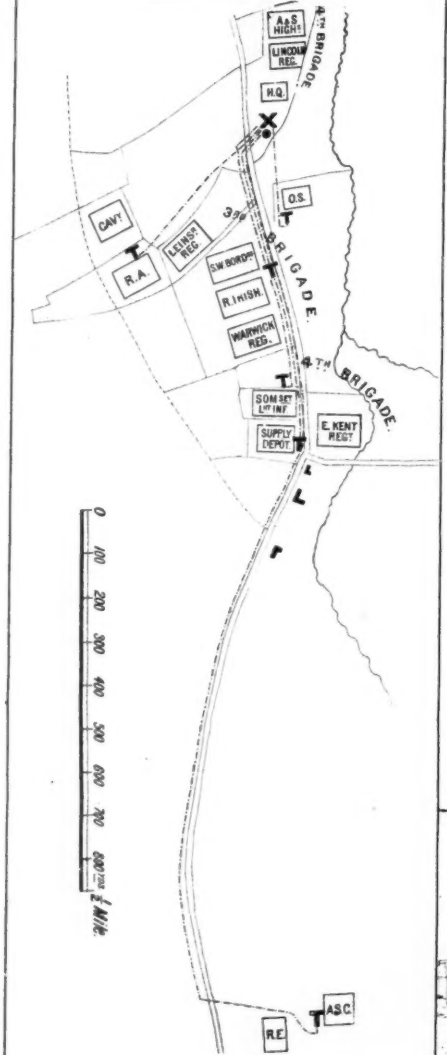
A field line 70 miles in length was run between Aldershot and Chatham, and on many occasions was used for telephone work. The line, running as it did through woods, and narrow lanes where contacts with trees and hedge-rows were unavoidable, was a very leaky one, but did not prevent the telephonic communication being carried on with fair success.

The instruments used were the "Ader" and the "Operators" telephone, and on the occasion of a ball which took place at Chatham animated conversation was kept up between the guests and some Officers at Aldershot. The "Ader" appeared to give the best results.

Intercommunication in Camps.

We are all familiar with the orderly and also with the fact that the orderly's duty is one of those that thin the ranks, so that any means

EAST MEON CAMP.



REFERENCE.

TELEPHONE ..... T
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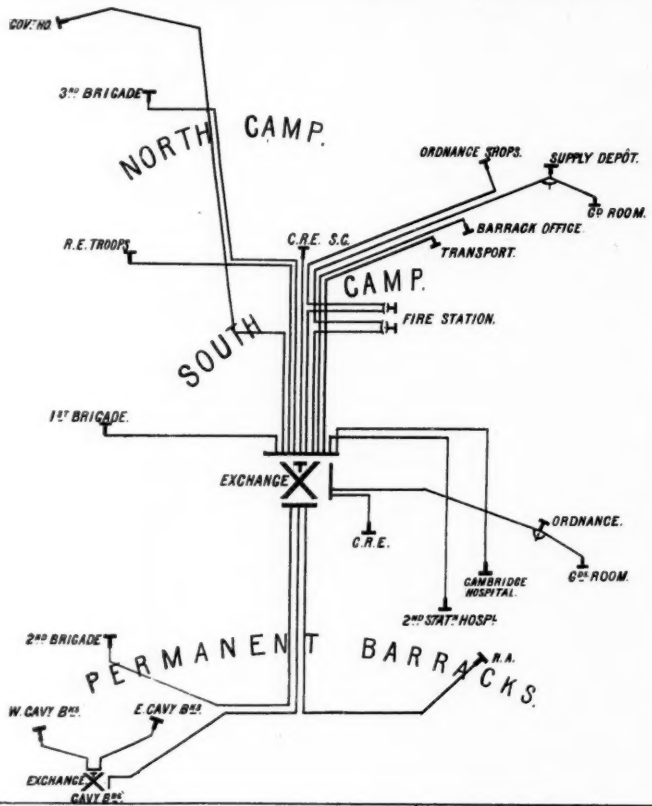
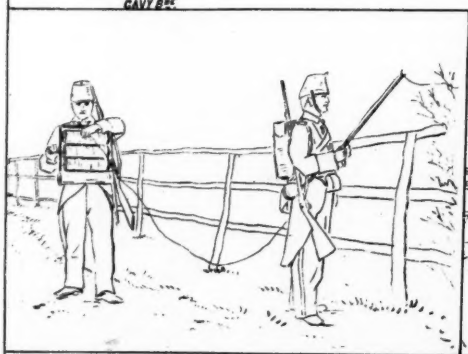
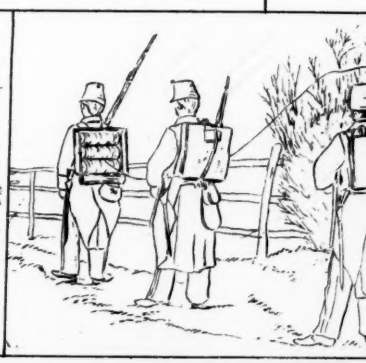
TELEPHONE LINE ——·——·——

TELEPHONE EXCHANGE SYSTEM AT ALDERSHOT.

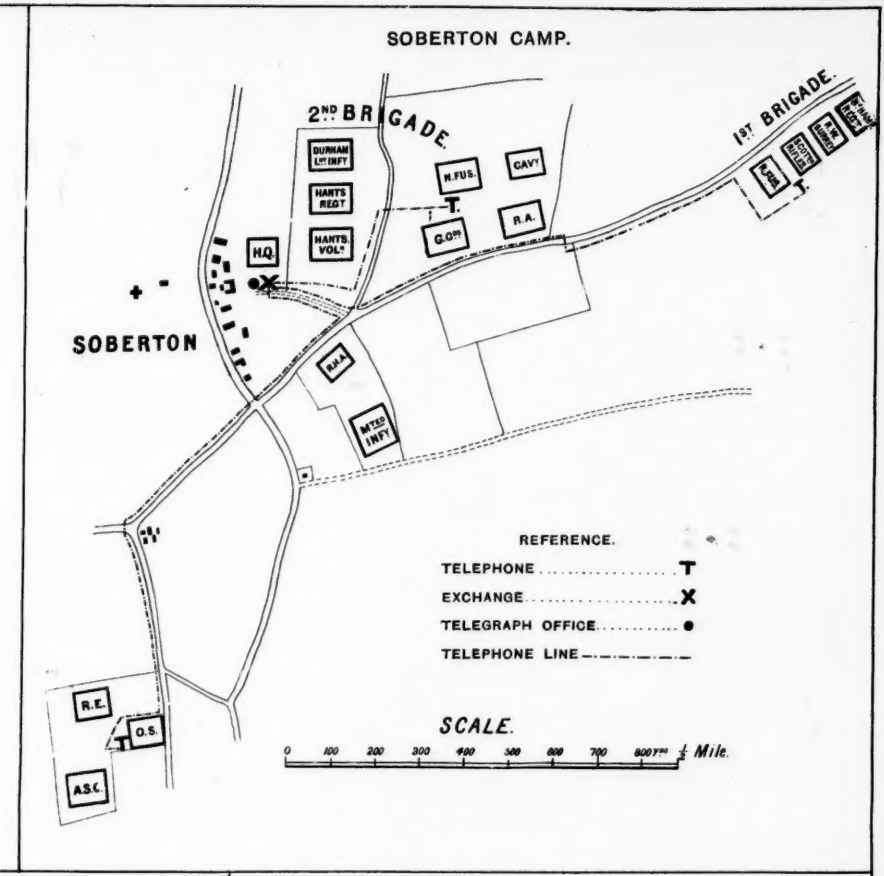


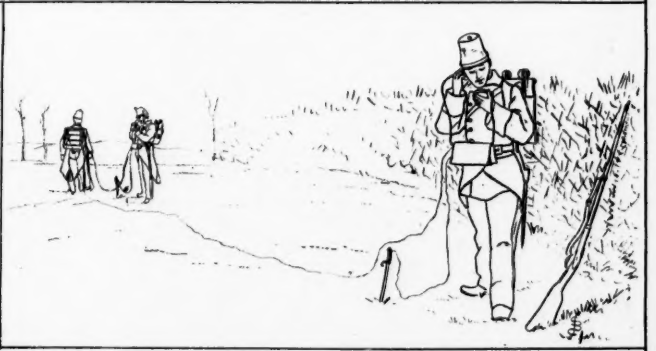




REGIMENTAL OUTPOST TEL

Harrison & Sons, Lith. St. Martins Lane W.C.





UTPOST TELEGRAPHS, BELGIUM.

which can be adopted for lightening his work cannot fail to be grateful to Commanding Officers.

The advantages of the telegraph or telephone over messenger, horse or foot, are so great and so well recognized as to render it unnecessary to repeat them here.

Telephone Exchange.

A telephone exchange gives us the power of putting any outlying office in direct communication with any other, so as to save the necessity of transmitting messages at a central station.

All commercial centres have long had their exchanges, and these are looked upon as indispensable for business transactions.

The first military exchange was established in Portsmouth garrison, over ten years ago. That at Aldershot was not established until within the last five or six years, but is now crowded with work. Plymouth followed suit some three years back, and the Curragh is meditating on the subject.

The naval dockyards have all, long since, had telephone exchanges.

The appliances of modern civilization are of slow growth in the British Army, but they come in the end.

During the summer manœuvres of last September, in Hampshire, exchanges were established in the camps of the two divisions, being the first instance, it is believed, of anything of the kind having been tried in the field.

The exchange switches were installed in separate tents close to the headquarter telegraph tent of each division, and the outlying offices were connected by air-line.

At East Meon these were six in number :—

(1.) The Army Service Corps and R.E. camp.
(2.) The supply depôt.
(3.) The Somerset Light Infantry camp.
(4.) The Warwickshire Regiment camp.
(5.) The cavalry and artillery camp.
(6.) The ordnance store.

The other regiments were so situated as not to require separate telephones.

At Soberton, the brigades being more concentrated, only three outlying stations were necessary, *i.e.* :—

(1.) First Brigade camp.
(2.) Second „ „
(3.) R.E., Army Service Corps, and Ordnance Store camps.

The exchange was in constant work during the manœuvres, and the results obtained may be judged of by the following extracts from opinions expressed by Commanding Officers.

A General Officer Commanding one Division reported as follows :—

"It was found to be of the very greatest convenience. The sending of the same amount of information by orderlies as was transacted

by telephone would have required the employment of ten times the number of men, and the saving in time was enormous."

A Brigadier wrote—

"There is no doubt that much time was saved by the use of the telephone."

And another—

"Undoubtedly the telephone exchange saved many orderlies."

While the following are among the opinions expressed by Officers commanding regiments:—

One reported—

"The saving of labour effected by it was the saving of distances to which it was necessary to send orderlies. . . . . There would not appear to be any saving in the number of times orderlies were sent out, but, the work being lightened, fewer orderlies could be employed."

Another says—

"I found them of the greatest use, owing to the rapidity with which messages were conveyed, more especially at East Meon, where there was a telephone office in our camp. They were certainly of much use in saving orderlies fatigue, and prevented the wear and tear of their boots and damage to men's clothes, which would have resulted from the muddy state of the road. But, as regards the number of men used, I should doubt if there was any advantage gained in only a divisional camp, for the number of telephone orderlies and clerks employed of my battalion (four at Soberton, and six at East Meon) would have amply sufficed to do the orderly work which was saved by the telephone, only of course with much less despatch."

As regards the above, it would appear that the duty of providing clerks fell more heavily on this regiment than on others, as only one clerk was necessary at each telephone tent, and two at the exchange.

A third Commanding Officer writes—

"Much advantage was derived by the use of the telephone exchanges at East Meon and Soberton. I am of opinion that the service of one orderly was saved."

A fourth—

"Considers that one orderly was saved."

A fifth says—

"The telephone exchange was very useful, and undoubtedly saved orderlies."

And another—

"If there is telephone communication brought actually into the orderly-room tent, the telephone is a good deal used. If the telephone is outside the camp, it is used very much less. For instance, at East Meon the telephone was much used by the battalions, whereas at Soberton, where the telephone was only a couple of hundred yards away, it was hardly used at all."

Others say—

"The telephone exchanges at East Meon and Soberton were of great convenience, and a great saving to the number of orderlies whom it would have been otherwise necessary to employ."

"The orderly was saved much walking."

And again—

"The distance traversed by orderlies was much reduced, but not the number of orderlies."

One or two Commanding Officers had not occasion to use the exchange for local communication, but arrangements having been made by which telegraph messages for Aldershot, sent by telephone to the exchange, were accepted at the telegraph office, they express themselves very favourably on the system.

This consensus of opinion leaves little doubt of the efficacy of a telephone exchange for camp work, or of the probable demand there will be in the future, and, considering the simplicity of the apparatus needful, there would appear to be no great obstacle to its adoption universally.

The question reduces itself to that of the men available for the erection and maintenance of such exchange systems.

On home service, the telegraph battalion can often manage to provide them, but on active service, when the whole of the energies of this body would be devoted to the lines of communication, I fear that telephone exchanges might go to the wall.

It then remains to be considered whether the advantages to be gained would warrant the necessary equipment being carried and maintained by regiments.

Taking it for granted that the R.E. could provide the exchange switch, which would be erected alongside the telegraph office, the following equipment would be necessary for each regiment:—

1 Telephone complete, with microphone transmitter.
1 Magneto call.
1 Small battery.
Half a mile of cable on a drum, weighing about 50 lbs.
A few small stores.

Thus equipped, a regiment would, as soon as its camp was pitched, lay its own cable up to the exchange office, where it would be attached to the switch by the telegraph battalion.

The original outlay for such an equipment would be about 20*l.*, with an annual expenditure of, perhaps, 5*l.*, and even if this was doubled the total amount would bear favourable comparison with the cost of one soldier, while it would probably set free the services of several.

The carriage of the stores would be trifling; there would not be more than what two men could carry with ease, the cable being on drums similar to those in use by foreign armies.

Outpost Telegraphs.

Under the head of outpost telegraphs there may be also included all light telegraph work in advance of an army, whether in repair and utilization of the lines of the country, temporary lines for local purposes, lines in connection with reconnaissances, or arrangements for tapping the enemy's wires.

We know that during the American Civil War the telegraph went ahead of all troops, with or without escort, generally the latter. We also know that during the Franco-German War of 1870-71 the telegraph work was frequently pushed ahead beyond the cavalry screen, and specially escorted for the purpose; such is the necessity in warfare of at once gaining communication to the front. We also see Continental Powers equipping their cavalry with the telephone and telegraph, but it is to the former that the greatest attention is being given. It might now appear to us time to enquire whether we should not be moving in the same direction.

The instruments at present at our disposal have been briefly described, and endeavours made to give an idea of the extent of their powers, so as to open up a field for discussion as to how far a telephone, whether in its simplest form, or in combination with microphones, or telegraph instruments, might be made use of for outpost work.

We are not now uncertain of our field lines, as we were in years gone by, when our equipment was of inferior material. There is now a cable in our Service, weighing 70 lbs. per mile, that will stand a strain of 500 lbs., that I have frequently seen passed over by artillery and remain intact. In the vibrating sounder we possess an instrument which in combination with a telephone will transmit signals through bare wire laid on the ground, and even in water.

It rests then with those in command to say whether such means of communication as have been described would be useful on outpost duties.

Whether occasions would not arise when to be able to speak between main body, reserve, and picquets might not be of infinite value.

Whether the establishment of some detached post might not entirely depend on the facility of communicating with it.

Whether the fact of being able to communicate immediately with the chief points of an outpost line would not reduce the number of men necessary for outpost duty.

Whether the knowledge that communication was open throughout would not give confidence to the soldier.

And finally whether the mere fact of lines of cable, radiating from certain centres, would not be of great use, especially at night, as providing guides for reinforcements and the like.

Then as regards the cavalry: should they not be in a position to tap an enemy's line (which can be done with the telephone), or to complete and work a deserted circuit, when the local instruments would probably have been taken away? Or to run short lines for connecting their headquarters with certain points, or with the head of the advancing main line of communication?

These are mere suggestions; other occasions for use of the telephone will probably occur to many of you.

It is as a Morse receiver that I look for the best results from the telephone in this direction. But this would require trained clerks.

Any intelligent man, with a good ear, can in a few months be

taught to read sufficiently well for most practical purposes connected with military local work. Many become fair operators in six months.

Most regimental signallers who pass through the Signalling School at Aldershot acquire there a fair knowledge of reading by sound, and it would be to those to whom the charge of regimental telephones would naturally fall.

But there are three chief reasons militating against the introduction of a regimental system of outpost telegraphy in the British Army:—

(1.) Expense,
(2.) Taking the soldier from the ranks for the purpose, and
(3.) If Morse signals are used, the difficulty of training men.

As regards the 1st, all that can be done is to simplify and cheapen the apparatus; and this is being accomplished year by year.

The 2nd reason might be met by the argument that adopting telephonic or telegraphic communication saves a number of men otherwise necessary for many duties.

The 3rd reason does not apply when the telephone is used only for talking, but, as it has been stated Morse signalling is perhaps the most effective for outpost work, this point must be considered, and is the most difficult to meet.

It is to be hoped that the cost of the telephone will be so reduced year by year, that before long a signalling instrument may be within everyone's reach, and become of common use in a barrack. One requiring no microphone, battery, or vibrator, but read by Morse. It would then be found that the art of reading the signals would spread of itself.

One good Morse clerk in a regiment could instruct many others during the year, without taking a man from other duties. Small prizes, as for musketry, would give the impulse.

It is from the hands of the signallers that we should expect the best results, and a regimental telephone equipment would double their power, giving them an alternative when signalling was out of the question.

The Telephone in Foreign Armies.

France.—The question of outpost telegraphs has been well to the front, for some years, in Continental armies.

France has taken the lead from the time that she saw what the telegraph effected in the war of 1866, and ever since that period she has striven to get the most out of the products of science.

Not only were telegraph sections created for the work on the lines of communications, but outpost telegraphs were from time to time experimented with, and organized in different branches of the service.

In each cavalry regiment there are six telegraphers, *i.e.*, two groups of three men each; and a light one-horse cart carrying four drums of cable in $\frac{1}{2}$ kilometre lengths, with the other equipment necessary.

Each cavalry division has a two-horse wagon carrying 30 kilometres of cable, batteries, and tools.

The telegraphers carry small batteries in their holsters, and telephones in their pouches.

What is known as "Trouvé's system" was introduced some years ago for dismounted outpost work, and consisted in a drum of double cable 1,000 kilometres in length carried on a man's back.

The instruments originally used were small watch-shaped sounders, and *a*, *b*, *c* instruments. These were soon superseded by Siemens' telephone, which about four years ago was itself superseded by the "Aubry" telephone.

Trouvé's system was first used during the siege of Paris.

Various methods of call have been tried with the telephone, mostly modifications of the reed, but the cavalry are now supplied with vibrators. There is still, however, a want of a more perfect means of ensuring attention being gained, and amongst other devices may be mentioned a form of head-dress by which telephones are strapped against the ears, and a microphone before the mouth. A pattern of this description invented by Colonel Roullez has, it is understood, been introduced into the artillery service.

Captain Zigang, a signalling Officer, has lately invented a call of the reed form which is said to give good results.

In 1879 and 1880 a great number of battalions of the 6th Army Corps were supplied with Siemens' telephones and 1,200 metres of cable each, but the experiments were not considered successful, and the advance of signalling at the time threw the subject temporarily into the shade.

The telegraph sections use Siemens' telephones, fitted with keys in the handle, for transmitting and receiving Morse signals, such signals being much more easily transmitted than the voice.

Berthon's pattern of telephone with magneto call has lately been introduced into the French service.

In his article on the French Armies, which appeared in the "Fortnightly Review" of November last, Sir Charles Dilke says, "The telephone was not, I heard, successful; the telegraph was very largely used."

This, it is to be supposed, entirely referred to the telephone as a "talking" instrument for outpost work, or on the lines of communication, and not for exchanges in camp, where there is no record of its having been used.

The following is an extract from an article by the special correspondent of the "Times," on the late French manœuvres:—

"In addition to the balloon, the field telegraph and telephone were there to assist the leaders; 50 kilometres of cable are carried with the first line of troops. Each cavalry regiment can lay 2,200 yards of telephone line, and, with the cavalry brigade and division, 12,000 yards of telegraph.

"In the actions in Champagne, even the troops in the fighting line were linked with headquarters, and the independent cavalry divisions established a line as they advanced.

"The work was very rapidly executed, the trees which line the chaussées greatly facilitating the operation, and allowing the line to be raised as quickly as the troops could march."

Germany.—Germany has had for some years the Buchholz-Siemens system for outpost telegraphs. The detachment to work it consists of 1 non-commissioned officer and 2 men. They are provided with a knapsack, carrying 500 metres of double cable, and 2 Siemens' recorders. The rate for paying out is 1 mile in $16\frac{1}{2}$ minutes. In 1879 Germany had material for 60 double stations of outpost telegraphs.

A combined telephone and microphone similar to that introduced into our service has lately been adopted.

In sending a message by telephone in Germany, the words are sent in groups of three or four at a time, and repeated by the receiving clerk; any difficult word, such as "Leszczynski," is spelt out in numerals, which are more easily transmitted by telephone than letters, a table of numerals to correspond with the letters of the alphabet being constructed.

There is a strong prejudice in Germany against the use of the telephone, on account of its not recording the messages.

Belgium.—In Belgium Major Waffelaert, the Officer Commanding the Telegraph Corps, is a strong advocate of telegraphs for outpost work, and has devoted much time and thought to this subject. The system he has adopted for the Army telegraphs is that known as "Rysselberghe's," whereby it is possible to use, at will, the telephone and telegraph instrument, simultaneously or otherwise, on the same circuit. One of his chief reasons for this system is that it is employed on the State telegraphs in Belgium, and Major Waffelaert considers the advantage of the military telegraphs being able to work in connection with those of the country.

In addition to the Telegraph Corps, there is in Belgium a system of regimental telegraphs that has an equipment of the lightest possible description.

The cable has a core of four phosphor bronze wires, and only weighs 13 lbs. per mile.

Its breaking strain is about 80 lbs. One man carries 1,200 metres of this cable on three drums, arranged in a frame of exactly the same dimensions as his ordinary knapsack, the load being about 24 lbs.

The instruments, comprising telephone, microphone, battery, induction coil, and call, are carried in the cartridge cases of the infantry, and in the holsters of the cavalry.

Vibrators and reeds are used as "calls," and the telephones can be held against the ear by elastic bands.

By adding a small condenser the apparatus can be fitted up, as in the "Rysselberghe" system, the vibrator being used for Morse signals.

Major Waffelaert considers that Morse signals are not adapted for outpost work, on account of the difficulty of obtaining trained clerks, a matter discussed in another place in this paper.

Italy.—Italy has been disposed to use telephones for military work

more than any other country. She was the first to make use of the vibrating armature for giving signals, and also makes use of the Morse key, in combination with the telephone.

Spain.—In Spain, owing to the mountainous character of the country, the whole telegraph equipment is of the lightest description, and carried on pack animals. Since 1859, the organization for using telegraphs for tactical purposes has been contemplated.

Mounted outpost telegraph detachments were formed in 1868, but, on account of the number of mounted men required to carry the equipment, these were discontinued.

For outpost work, the original instrument was the "Trouvé" sounder, but this has since been replaced by the telephone and Morse key combined, as in Italy.

In Spain the outpost telegraph is pushed right up to the outpost line of picquets, and, it is said, with good result.

Russia.—Some eight or nine years ago an outpost instrument ("Horschelmann's") was introduced into the Russian cavalry; it was similar to the "Buchholz" of Germany, and carried on the saddle.

This was tried by the Uhlan Regiment of the Guard, and, from the results obtained, introduced into all the cavalry regiments. Whether it has been superseded by the telephone I am unable to say.

Austria.—Cavalry telegraphs were organized last year, for the purpose of connecting cavalry divisions with the nearest telegraph stations, and enabling them to make immediate use of the telegraph lines of the country. The telephone, no doubt, will be largely used for the purpose.

Conclusion.

A statement of what might be expected from the telephone in its present development having been laid before you, and suggestions made as to its employment, it only remains to touch on certain drawbacks attending the use, or rather the improper use, of both telephone and telegraph; classing the two together under one head.

In a recent article published in the Proceedings of this Institution it was stated that "the employment of this technical auxiliary in the first line restricts the high mobility of present warfare." It is possible, and even probable, that the telephone will often create unnecessary correspondence.

The ease with which communications can be held will offer temptation to the more feeble to seek the shelter of non-responsibility, to the wavering increased facilities for vacillation, and to some others improved openings for making their presence (in the spirit) felt when least desirable. All this, I have no doubt, the writer had in his mind—in fact he saw centralization encouraged by the telephone.

But there is another side to the picture. In a very remarkable article published by this Institution, in 1887, and entitled the "March and the Battle," the following gives the key-note:—

"The little influence thus possessed by the Commander-in-Chief, in choosing the occasion for decisive action, is really an element of great difficulty in the warfare of the present day."

The whole of the article appears to me a most forcible argument, unintentionally, but unmistakably, showing the necessity for a wide extension of the telegraph. The urgent demand for that unity of action almost, if not altogether, lost under the conditions of modern war: "a great united effort instead of a number of isolated blows."

I would ask whether the telegraph restricted the mobility in the American Civil War; or, again, whether it did so in the Franco-German War. The history of the telegraph (and it is written for both) is a series of brilliant records of its achievements. "Technical art is striving hard to discover fresh means for enlarging the influence of those in supreme command," and the telephone is its latest effort.

The CHAIRMAN: I have no doubt that there are among you some Officers of the Royal Artillery, both garrison and field—superior Officers, who are able to speak upon the advantages of the facility of concentrating fire by means of the electric telegraph, either by the telephone used as a sounder, by the Morse telegraph, or by the sound of the voice, and I dare say there are Engineer Officers here who will be able to speak of the value of telegraphy for siege purposes. Doubtless there are also here Officers of the infantry who will be able to give us their valuable opinions as to how far the telegraph or the telephone can be used and trusted as an instrument in time of war, whether at the front or how far to the front. The discussion is now open, and we shall be very glad to hear what Officers may have to say.

Colonel KEYSER (Inspector of Signalling, Aldershot): General Feilding and gentlemen, I am very sorry that I should be the first to throw myself into the breach of discussion, but as Major Beresford and I have now for many years worked, I may say, side by side, and I hope always in harmony, I think it would be as well if I commenced by pointing out that in many particulars I agree with him entirely as to the signallers of the Army being able to carry out all that he has proposed in his lecture. I am perfectly certain that with perhaps less than a fortnight's instruction any signaller in the cavalry or infantry could easily manipulate a Morse sounder. It would not only be an advantage for them to be able to do so, but it ought to be a necessity; no infantry or cavalry signaller's education should be complete until they have gone through a modified course of telegraphy. I pointed out in a lecture a short time ago, at Aldershot, that in my opinion every cavalry signaller should be taught the rudiments of telegraphy, how to tackle wire, the nature of a battery, the reason why batteries act, the way to repair wires, the way to repair batteries, and any small details of that sort, and I am sure, such is the intelligence of the modern signaller, that in a very short time he would be taught to do this. We are quite pleased that the Royal Engineers should be the brains of the Army as far as telegraphy goes, but I think that the signallers ought to be the arms and legs, and I am perfectly certain, in a very short time it will come to this, that on service the whole practical work of sending and receiving will be done by the signallers; in fact, my opinion is that there ought to be one central school—I do not care who is at the head of it, whether an infantry man, a cavalry man, or a Royal Engineer—there ought to be one central school of telegraphy, where every means of conveying intelligence, including visional signalling, which is really almost part, you may say, of telegraphy, should be taught by the various professors, and these school men once turned out, ought to be permanent signallers, and enlisted as such. At the present time you take a well-educated man and make him a signaller: what is the result? I have taken the trouble to find out how long a man remains a signaller, and on the average I find he is only with his regiment for three years. After that he either goes to the Reserve, or finding that he is possessed of some intelligence which has never been brought out before, and which he did not know he possessed, he plucks up spirit, takes a stripe, and becomes a non-commissioned officer, and is lost to signalling. If signalling were more recognized, and treated as

a whole, telegraphy, telephoning, and signalling, this sort of thing would be altered, and a signaller would be a signaller and nothing else. There are very few required, and I am sure the advantages gained would more than compensate the loss of a few men per regiment. The lecturer talked about the feelings of Officers as to orderlies, that orderlies were not so much wanted at manœuvres, and most of them say that the use of the telephone did away with one orderly. The real reason why orderlies are still so much a necessity is that Commanding Officers are afraid of the telephone. They get an order through the telephone; they are not quite certain whether it is an order. They act upon it as a rule, but until an order becomes a written message they are not happy. That will always be so until a rule is made that every message through the telephone must have been written and signed, so that in the evening all these messages are collected and checked at the receiving place. Then they will know that they can rely upon a telephone message; but if a Commanding Officer thinks that anybody who likes can go and shout a message to him through a telephone, he does not know where he is, and he is rather afraid to act upon it. I am sure the lecture we have had is most instructive and interesting, and I am very sorry there are so few here comparatively to have heard it. The whole of the British Army ought to have been here.

Major WAFFELAERT, Belgian Army (translation): Gentlemen, I beg you to excuse me if I speak in French, as I have not sufficient practice to enable me to speak English correctly. If I speak at all, it is in order to draw the attention of the meeting to one point. It seems that an outpost apparatus should be simple, strong, and small. It must be simple, so as not to be liable to get out of order; strong, so that it may be placed in the hands of soldiers unskilled in the handling of delicate apparatus, and often handling them roughly; lastly, it should be small, in order to facilitate transport. For these reasons a good magnetic telephone, which can be also used as transmitter, would be the best apparatus for outposts, but for certain drawbacks which Major Beresford has pointed out. Now it appears from our experiments that the greater part of these drawbacks disappears when the soldier with the telephone can hold an instrument to each ear. In this case the soldier, even though little used to telephoning, understands the person talking much more easily, even when the latter speaks indistinctly. It is thus a question of a head fixing. We have found that an ordinary elastic band fixed to the telephone and passing obliquely round the head is a good fixing. Each year we erect lines at the camp of Beverloo for observing artillery practice, and the Siemens' telephone used as transmitter has always given excellent results. The same is true of the Dehorowicz telephone, which is not larger than the Ader. I greatly admire Captain Cardew's vibrating sounder when the lines can be operated by specialists.

Major G. W. ADDISON, R.E.: Perhaps, as I am not altogether in accord with my friend Major Beresford in his proposals, I may, by speaking now, do something to promote discussion. Major Beresford has said very little in his lecture about the chief use which we make of the telephone in time of peace. I mean as regards the telephone systems in garrisons and fortresses. That is a large question, and I am afraid the time allowed to me would not admit of my dealing satisfactorily with it, and, therefore, I will pass on to those details which he has gone into in connection with telegraphs and telephones in the field. The first is "field telephone exchanges." Major Beresford recommends that each infantry regiment should be provided with a telephone equipment, so that as soon as it comes into camp it would be able to lay a cable up to the exchange office and attach on to the exchange switch. I do not know how he reconciles that with what he says in the introductory paragraphs of the lecture, viz., "The telephone, in its complete form with microphone and call apparatus, is a more or less delicate instrument, and requires an intimate acquaintance with its idiosyncrasies to keep it in good working order." It is true he goes on to say he hopes the telephone will be very much simplified, and I have no doubt it will; but personally I cannot say that I think you will be able to trust to any soldier without technical training—I do not care what branch of the Service he belongs to—to walk up and connect you with a field telephone exchange in this way. By the time we reach that stage, I think we may also hope to have got the army of shorthand writers which Major Beresford appears to desire. Then as to "cavalry telegraphs," which I prefer to separate from outpost telegraphs

proper. Major Beresford has given us a very interesting account of what foreign nations have done and are doing in this direction, and especially as regards the French equipment. The French, undoubtedly, up to a certain point, have got their telegraphic arrangements for a campaign more perfect than any other nation. In their organization they attach six telegraphers to each cavalry regiment; but Major Beresford has not mentioned what I think is the most important point of all, and that is, that these telegraphists are not men trained, as Colonel Keyser would wish to try to train them, in military schools; they are first class telegraphists. The French consider that for work at the front they need better telegraphists than anywhere else. The cavalry telegraphists are either men who having been trained in the Post Office, are serving in the Army (cavalry), or men who, after being cavalry soldiers, are employed in the Post Office during their Army Reserve service. The great object of having cavalry telegraphists in the French Army seems to be to utilize the existing telegraphs of the country, and they naturally do not care about the telephone for this purpose, but they are prepared to use it where they can. As regards "tapping" messages sent by the enemy, the French express some doubt whether that can be done very much; because they use on the Continent, to a considerable extent, a form of apparatus—the Hughes—which cannot be "tapped." It is quite certain that it is no easy matter to "tap" a telegraph line when messages are sent at fast speed and in a foreign language, and you are not going to do this by regimental signallers, however well trained. I confess I do not much care about a *regimental* telegraph or telephone equipment for cavalry. I think it is the one thing above all others which is likely to lead to that feeling, alluded to by Major Beresford, of telegraphs proving a check upon the initiative of Officers in the field. Take the case of a cavalry regiment at the front, with its telephone or telegraph connected up to headquarters. An energetic Colonel may, probably, send back many messages on scanty information, and the General will soon look upon them all as valueless if not mischievous! On the other hand, the Colonel may find a Staff Officer at headquarters moving him about and ordering him in every direction, I think you had better attach a certain number of telegraphists to a cavalry division, and let the Officer commanding the division have an equipment which would enable him either to keep in communication with headquarters, or to maintain communication with any particular regiment detached for special service. In any case I would wish to say again that the telegraphists must be the very best you can get. Then I come to outpost telegraphy proper. There is often a great deal of confusion on this subject, because, as Major Beresford points out, all telegraph work in advance of an Army may be called outpost telegraphy. In the French organization the sections of the first line are only supposed to keep up communication between one Army Corps and another, and between Army Corps and the Army Headquarters in the rear; these sections do not provide any communications with "divisions" which are considered special duties to be provided for somehow by the General Officer Commanding the Army Corps. With us the division is a much more important part of the field army than it is in the huge armies of the Continent, and our telegraph battalion undertakes, as part of its work, to keep the headquarters of an Army Corps in touch with its divisions. Therefore when we talk of outpost telegraphy we mean what Major Beresford refers to in the lecture, that is to say, to electrical communications with the piquets and sentries in front of an Army at rest. If you have outposts out in foggy weather, &c., there cannot be a doubt that some electrical system of communication would be a great advantage. It would enable the army to rest more quietly and comfortably if they knew that they were certain to get early warning of an attack. Whether you had better use the telephone or the telegraph for such a purpose is still an open question. Major Beresford admits, in most of the extracts he has given in his lecture, that foreign countries are not much in favour of the telephone. Personally I think you must have a trained staff to look after the telephone (if it goes wrong an untrained man won't know what to do with it), and if you are to have trained men they may as well be telegraphists, and then it is perfectly immaterial what form of instrument you adopt; they will be able to use whatever is the best suited to the circumstances. My moral then is a simple one: if you think this advanced tele-

graphy in any form—I do not care whether cavalry or outpost—is really worth having, you must make it as perfect as possible, and you must be prepared to pay the cost of adding, if necessary, to your telegraph battalion.[1]

Major BERESFORD: General Feilding and gentlemen, I quite sympathize with the remarks Colonel Keyser made about the difficulty of getting men from regiments for training as signallers. I have experienced the same difficulty myself in obtaining men from the various regiments at Aldershot for training as telegraphists. As long as the Officers Commanding regiments have nothing whatever to do with telegraphs themselves, and have no interest in them, they will not give it the men if they can help it. If it was to their own interest to produce telegraphers, and if they had a regimental equipment at their disposal, they would produce them fast enough, and, no doubt, undertake that they should become good telegraphers. With regard to written messages, at Aldershot all telephone messages are written out just in the same way as telegraph messages. At the telegraph exchange, on manœuvres, the messages were written out or not as the senders thought fit. The necessary forms were at their disposal. Colonel Keyser thinks the whole of the British Army ought to have been here. I only hope the whole of the British Army will consider whether they could not build a better theatre than this to hold them if they did come. I have to thank Major Waffelaert very warmly for taking part in this discussion. Major Addison questions the ability of the British Line soldiers to gain an intimate acquaintance with the telephone. I do not question that at all. I know the Line regiments have many men of considerable ability, men of all kinds of trades, mechanics and others, and I venture to say that in every regiment of the British Army there are several, half a dozen or more, who, with a week's training, would be perfectly competent to undertake the charge of telephones such as are used on exchanges.[2] I will just state what I once saw with regard to the Fire Brigade telegraph system in London. I was going round a station with Captain Shaw, and I there saw delicate ABC instruments (and there are no instruments more delicate) in the men's rooms. I asked him if he left them there to be knocked about and tampered with? He said he left them there on purpose, because he found, by so doing, that the men took an interest in them; they came to know them, and kept them in order, and he had no trouble whatever in the matter. On the subject of the French telegraphs I had a good deal more to say, but time did not admit of it. I did not, therefore, enter into the question very closely. The original French cavalry telegraph service was practically organized by the Decree of 1884. There is another Decree of 1889, which has considerably altered the first organization, and made the personnel far more telegraphers than cavalry soldiers; in fact, they do little or no duty as cavalry soldiers now. There is a cavalry telegraph school, under the command of a Captain of cavalry, who only looks after discipline, but does not interfere with training. The latter is under a functionary of the military telegraph department. While with the Army the men are employed thirty-six hours a month in the Government telegraph offices, so that they become fair telegraphers. I hear from an Officer present at the last French manœuvres that in every direction he saw the telegraph and telephone at work with the cavalry and artillery.[3]

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[1] My remarks were in no way intended to discourage the training of visual signallers as telegraph operators, but experience has conclusively shown that the limit is soon reached to which such instruction can profitably be given. The problems of outpost telegraphy are not, in my opinion, to be solved by this means.—G. W. A.

[2] But for outpost work, when the telephones would be necessarily placed in many different hands, the simplest form of instrument suited to all would be required.

[3] List of additional apparatus exhibited, not previously mentioned in the paper, and kindly lent for the purpose by the undermentioned:—

By Messrs. Siemens Brothers—
Hellesen's dry-cell battery.
Knapsack, with cable, for outpost work.
Samples of cable, &c.

The CHAIRMAN (General Feilding): Gentlemen, it is a subject of great regret to me, and I think it must be to most of you, that there have been no Officers of the Royal Artillery or the cavalry who have taken part in the discussion. They might have a great deal to say on this all-important subject, as showing how, in these days of large armies and vast assemblages of guns, it enables us to get all the advantages resulting from concentration of fire without having to send mounted orderlies and *aides-de-camp* to create that concentration at a given moment. We should like also to have heard some cavalry Officers speak upon this subject. In the Franco-German War, of which I had the honour of seeing a good deal, the Germans constantly did tap the French lines to my knowledge, and to my own detriment on one occasion, and they quietly spoke in French along these wires, and used the French codes, which they had got hold of, and caused considerable confusion at headquarters more than once. I think telegraphists ought, where it is possible, to use the telephone, because it is not easy for a man to imitate the voice of another person, especially if he does not know whose voice it is he is to imitate. If you expect to hear a certain man speak and you hear somebody else your suspicions are at once aroused. I do hope, as Colonel Keyser says, more encouragement will be given to our infantry soldiers to learn the telephone and telegraph, and to get fully acquainted with all the apparatus connected with it. It will be of great use to them in civil life when they go to the Reserve, and afterwards when they pass into civil life permanently. The difficulty that we have in finding permanent employment in civil life for our infantry soldiers is that, unlike the cavalry, artillery and engineers, and other departmental corps, they have, generally speaking, not learnt any particular profession, and if they did belong for a short time as boys to any particular profession beforehand they have had time to forget it, and they generally have managed to forget it thoroughly. Major Addison spoke, it seemed to me, with a considerable amount of sense as to whether the telegraphic equipment should be regimental, brigade, division, or corps. My own experience in the Franco-German War was that it was then under Post Office officials. There it was a corps organization altogether, formed of civilians, who wore a sort of military uniform, On more than one occasion it was pushed forward to the outposts, and with very satisfactory results after the taking of Orléans the first time. On one occasion, the 2nd of December, when the line of battle extended over 30 miles of ground, and where it was necessary to have rapid communication with headquarters, it was of very great importance to be able to connect with headquarters the outposts at the extreme flanks of an enemy so extended in front. Our friends on the Continent, as you all know, have begun to train dogs for the purpose of communicating with outposts. I am not aware that our own Army have embarked upon that experiment. Dogs are said to be extremely useful in this capacity; but I think it is open to doubt whether they are so absolutely reliable as such a means of communication should be for such very important purposes. Dogs may be shot, they may be entrapped; many things may be done to divert them from their proper course. Telegraphy is a little more difficult to divert in that way, and therefore more dependable. I sincerely hope that one of the results of this very interesting lecture which we have heard from our esteemed friend Major Beresford may be that the military authorities will take even more interest than they do at present in the

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By the G.P.O.—
D'Arsonval's telephone.
The original telephone brought into England by Mr. Preece.
The new Gower-Bell.
The operator's receiver for fitting to the ears, &c.

By the Consolidated Telephone Company—
The Divers' telephonic apparatus.
The domestic switch board.
The Fitzgerald telephone.
The portable Gower-Bell.
The Bell-Blake magneto-combination
Form of operator's receiver, &c.

development of this most important branch of the Service. We are, I think, always a little behindhand in England in adopting inventions. I recollect in America in 1877 there was a speaking telephone between Boston and New York. It was a long time after that before it became of commercial use here. In England, however, when we do take a thing up, though it does take a long time to adopt a new invention, we generally manage to make it very perfect and make it very practically useful. I do hope that by this discussion we have had to-day, and other discussions which I hope will arise out of it at some future lecture, we may benefit not only ourselves but the Service generally. I venture to take it for granted that you will all agree with me in passing an unanimous vote of thanks to Major Beresford for the extremely interesting lecture he has given us, and for the pains that he has taken to get these valuable collections of electrical instruments together, and to explain them to us. I am glad also that you have been able to welcome our distinguished military friend, Major Waffelaert, of the Belgian Service, who has done a great deal of useful work in the perfection of a military system of telegraphy in that important country.

Friday, February 26, 1892.

GENERAL SIR C. P. BEAUCHAMP WALKER, K.C.B., Vice-President, in the Chair.

THE RECONNAISSANCE OF A RAILWAY: ITS UTILIZATION AND DESTRUCTION IN TIME OF WAR.

By Colonel J. S. ROTHWELL, R.A., p.s.c., Professor of Military Administration, Staff College.

Introduction.

THE reconnaissance of a road is a military problem with which, in these days, most of us are sufficiently well acquainted, but it is rare in this country to find any Officer who has had experience in executing a reconnaissance of a railway. This is not due to any failure on our part to recognize the importance of railways in war, but it is to be attributed to that fact which makes itself felt so constantly in all our military arrangements, viz., that we are not a Continental Power.

If our railways were continuous with those of one or more foreign States, the question of the reconnaissance of railways on both sides of the frontier would assume a prominence far beyond the position which it occupies at present; but, so long as these islands can only be reached by ship, a detailed reconnaissance of most of our home railways would have but little military value, while time spent on examining our neighbours' lines in view of possible contingencies would be absolutely wasted. It is said that before the outbreak of the war of 1870 German Officers had ascertained the exact dimensions of every bridge on the French lines leading to Paris, and that, when in the course of the operations it was reported that a certain bridge had been destroyed, girders of the proper size for its repair could be at once forwarded from Germany or elsewhere. Nothing of this sort is necessary for us. We have no intention of invading the territories of our Continental neighbours, and the prospect of an invasion of our own islands excites no apprehension, and awakens but little interest.

There are, in fact, only two regions in the world where railway trains can run from British territory direct on to the lines of a foreign State, and *vice versâ;* these being in North America and in South Africa.

In North America the lines of the Dominion of Canada connect at various points with the railway system of the United States, while in South Africa the railways of the Cape Colony and of Natal are already in touch with those of the Orange Free State, and in the near future

will probably be joined to such lines as the Government of the Transvaal Republic may see fit to construct.

There is, however, in the more remote future, a prospect of a railway connection being accomplished which, if it ever takes place, will have a greater military interest than those junctions in America and in Africa, and that is the union of the Russian Asiatic system with our Indian network. Roughly speaking, these railways at their nearest points are less than 600 miles apart as the crow flies (just the distance from Land's End to John o' Groat's House), representing, perhaps, 800 miles to be constructed in order to unite them; and, if this gap should be bridged over, there will be some interesting problems in railway reconnaissance to be worked out by those who may then be responsible for such matters.

It may appear to some persons that, so far as regards railways within our own territories, a special military reconnaissance is unnecessary, inasmuch as the fullest particulars as to their construction and working can be obtained from the officials of the company. The difficulty, however, is that while in some respects these particulars will be very full, and possibly too full, other information, especially if of purely military importance, cannot be obtained from the same source, and it will therefore generally be desirable to assign to a military Officer the duty of collecting the required information.

The Reconnaissance of a Railway.

Our first business to-day is to consider what would be required of an Officer charged with the carrying out of such a reconnaissance; that is to say, how he should observe, and what he should note.

To begin with, it may be at once laid down that an Officer travelling as an ordinary passenger in a railway carriage is not in a position to observe the military features of a railway, even though he may perform the journey many times. A special train is not likely to be at his disposal, and in any case it is not so convenient as the ordinary platelayers' trolley with a few men to push it. Seated on this a good view is obtained in all directions, and when any points have to be specially examined, there is no difficulty about leaving the vehicle, which is only a foot or two above the rails. There is also this advantage in reconnoitring from a trolley, that when the line is not in actual use—as in the case of a railway abandoned by the enemy—the passage of the vehicle along the line is a proof that the gauge is true, and affords to some extent a guarantee that no concealed mines have been laid.

In many cases, however, the reconnaissance must be carried out on foot, and as this may be done while trains are running on the line, it will perhaps not be superfluous to give a word of caution as to walking along a railway.

Accidents are generally caused either by a train coming up unperceived from behind, as may happen when there is a high wind, for instance; or else when a person who is walking in the six-foot way steps back into the down line to avoid the blast of a train travelling

on the up line, and is then struck by a down train passing at the same moment. The rule of never walking between the metals—especially on a single line—should therefore be most carefully observed, but, if it cannot be avoided, it is best to choose that line of way on which trains will be met, approaching from the front; that is to say, on an ordinary double line, the right-hand road.

The next thing to be considered is, what ought to be noted when making a reconnaissance of a railway, and this may be grouped under three main heads, viz. :—

The Permanent Way.
Stations and Signals.
Rolling Stock.

The permanent way, as is well known, is the term applied to the railway in its finished condition, as contrasted with the temporary lines used while the work of construction was still in progress. It may be single or double, and, in a few cases, even triple or quadruple, but if it is only single, as is usually the case abroad on all except main lines, it is of importance to ascertain whether bridges, tunnels, and earthworks have been made wide enough to allow a second line to be laid. This width depends to a considerable extent upon the gauge, but does not depend on this exclusively, as, in order to obtain increased accommodation, it is usual on lines with less than the normal gauge to make the superstructure of the carriages nearly as wide as it is on lines of the wider gauge, and thus what is termed the "over-hang" of the carriages, and which determines the width of bridges, tunnels, &c., may be abnormally great.

The gauge of a railway, being a matter of the first importance, should always be noted in a reconnaissance of the line. In this country we are so much accustomed to the uniform gauge which has been adopted on all lines except part of the Great Western system that we might be disposed to fancy that a similar uniformity is to be found elsewhere; but this is not the case, for in Brazil seven different gauges are in use, and in the United States eight, while many other countries have a broad gauge for their trunk lines and a narrow gauge for the branch lines. An Officer making a reconnaissance of a railway out of England should therefore never take the gauge for granted, but should always measure it, and for this and other purposes it may be mentioned that a walking stick, marked off by small notches into feet and inches, will be found a very useful companion when making such a reconnaissance.

The normal gauge which has just been referred to, and which is in use in England and throughout the Continent of Europe, with the exception of Russia, Spain, and Portugal, is, as is well known, 4 feet $8\frac{1}{2}$ inches. There is no special virtue or symmetry about such a width between the rails to account for its selection, and the explanation of the fact that the great majority of lines in the world are thus laid is to be found in the history of the first railway worked by a locomotive, in whose wake the rest have followed. When this line between Stockton and Darlington was built, it was made to take engines of the same size as

George Stephenson, its engineer, had previously used successfully on the Killingworth tramway, and the gauge of this had been determined by the track of the ordinary coal wagons of the country drawn by horses, to suit which a wooden, and afterwards an iron, tramway had been originally laid down.

The modern railway can thus, by a process of evolution, trace its descent from the wagon ways of the north of England, and the distance between the wheels of the rude trucks there used has been transmitted unchanged to the elaborate vehicles now running over the greater part of the civilized world.

The next point to be noted with respect to the permanent way is the mode in which it is laid, whether on transverse or longitudinal sleepers, and how the rails are secured to the sleepers. If chairs are used, as is the case on most of our English railways, with the double-headed or bull-headed rails, it is necessary to observe the form of the chairs, and the manner in which they are bolted to the sleepers.

Proceeding along the line, the reconnoitring Officer would note the gradients with the distance over which each extends, and it may not be undesirable to mention that the report should never omit to state in which direction the line rises or falls, as the simple statement that at a particular place a gradient of 1 in 250 occurs conveys no definite meaning unless it is supplemented by the words "rising towards X," or "falling towards Y." The special object aimed at in recording the gradients on the line is to ascertain the maximum or, as it is generally termed, the "ruling" gradient, on which the proper working of the traffic largely depends, as it is this gradient which determines the locomotive force necessary. In the case of our own lines, such particulars might be obtained at the offices of the railway company, but it is hardly likely that information of this nature will be accessible under all circumstances without direct observation. This, however, is easily obtained, as on every line the gradients are clearly marked for the benefit of the engine drivers, and the correct figures can be written down in a reconnaissance report.

The dimensions, material, and construction of all culverts, bridges, and viaducts would naturally be noted, and in the case of tunnels the report should mention whether they are cased with brickwork throughout, and should also indicate the nature of the rock or soil through which the tunnel has been pierced. The height of embankments and the depth of cuttings must also be observed, and the nature of the strata through which the latter have been cut, and it is also important to note whether their sides are revetted, and at what angles they stand.

Stations and Signals.

Stations may be either "terminal" or "road-side," and are further classed as *passenger* stations and *goods* stations; the ordinary country station on a through line being, for instance, correctly described as a "road-side passenger and goods station." To enable a just opinion to be formed of the value of a station for military purposes, one of

the first things to be done is to make a ground plan of it. The most convenient scale for such a plan has been found to be $\frac{1}{2160}$, or sixty yards to one inch, and in order to avoid a multiplicity of lines it is usual to represent each "road" or pair of rails by a single thick line. In order to obtain additional clearness, especially where the station is a large one, the lines may be represented at wider intervals apart than they actually are, but if the lateral distances are thus exaggerated, the fact should be distinctly stated on the plan, as it may otherwise give a very erroneous impression of the actual amount of space available. The plan of a railway station for a military reconnaissance need not be drawn with minute accuracy, but it must show the essential points correctly. These include the way in which the different sidings connect with the main lines, the correct positions of points and cross-over roads, and the length and position of platforms and sidings.

Military trains being, as a rule, longer than the passenger or goods trains which ordinarily run on English lines, it will usually be a matter of great consequence to know whether a given siding will hold a given military train; as, if the siding is too short, and the train has to be divided, much delay and inconvenience will be the result. In the same way, on a single line, it is important to know whether the portions of double line, or passing places, are long enough for a military train, and this is not always apparent from a plan. The information which is actually wanted is the length of train which can stand in a siding, or at a passing place, without interfering with the traffic on the adjoining line of rails; and if this is obtained by measuring on the plan the length of the siding from the point where it is shown as diverging from the main line, it will generally be found that the length so arrived at is some fifty yards longer than it is in reality. It is, therefore, necessary to note on the plan the "available length" of each siding, this length being measured from the point where the siding has diverged so far from its neighbour as to be perfectly safe from all risk of collision. As to clear the overhang of ordinary English railway carriages 2 feet 3 inches must be allowed on each side, it follows that no part of a siding is available where there is an adjoining line used for traffic at a less distance than 4 feet 6 inches.

In reporting on a railway station, it is also necessary to mention any turntables, cranes, or other appliances which might be useful, and to give a description of the buildings, and of the manner in which they are lighted. The number of railway officials usually employed ought to be noted, as well as the coal and water supply available, the means of watering engines being, of course, especially important, and the source from which the water cranes or stand-pipes are supplied.

The exact dimensions of all existing platforms should be given, the height being always taken from the rail level, and not from the ground, and any spare material, such as rails or sleepers, which might be utilized for the construction of additional platforms, should also be specified, and its position marked on the plan.

In view of the possibility of the station being required for the

entrainment or detrainment of troops, the approaches to it must not be neglected, their nature, width, and gradient being all subjects for the report; and as, especially for entraining, it is desirable to have a halting place close to the station, any fields or other open spaces which may serve for this purpose should be indicated, and their approximate dimensions given, if they are not shown on the plan.

As regards signals, their nature should be reported on, and if the block system is in use, the various sections into which the line is divided should be explained. The means of telegraphic communication are practically part of the signalling system, and, as they are of special value in military operations, they would naturally be included in the report.

Rolling Stock.

In making a reconnaissance of a railway, it would further be necessary to report on the rolling stock, mentioning the numbers of each class of vehicle, their condition, the nature of brake with which they are fitted, and whether there is any source from which their numbers might be supplemented. To report upon the condition of a locomotive is a matter which is rather more than can be expected of everyone; but there are some Officers now serving who have had an opportunity of going through a course of practical instruction in the engine shops of some of our great railway companies, and who have gained a valuable knowledge of the locomotive by working with their own hands on the engines sent into the sheds for repairs.

It is not difficult to imagine circumstances in which knowledge of this sort might be of the greatest value; but there is no Government establishment in which a British Officer could gain the necessary instruction, and admission to the workshops of a railway company is a favour which is not granted indiscriminately. In most cases, therefore, the portion of the report on a railway which deals with the locomotives must be second-hand, and it must only be hoped that an Officer receiving such a report from an expert would have sufficient acuteness to judge of its value tolerably correctly.

The condition of other classes of rolling stock and their suitability for military purposes are matters which are within the competence of most Officers to estimate, the great points being the strength and soundness of the flooring of vehicles intended to carry horses and guns.

The foregoing are the principal points on which information would ordinarily be required in making a reconnaissance of a railway; but, under certain circumstances, it might also be necessary to examine the country in the neighbourhood of the various stations, either as to its furnishing camping grounds for troops, or else as affording a position for defence, if the stations should become objects of attack by the enemy's forces.

Under other circumstances, the reconnaissance of a railway might include a survey of the country near a tunnel, in order to determine

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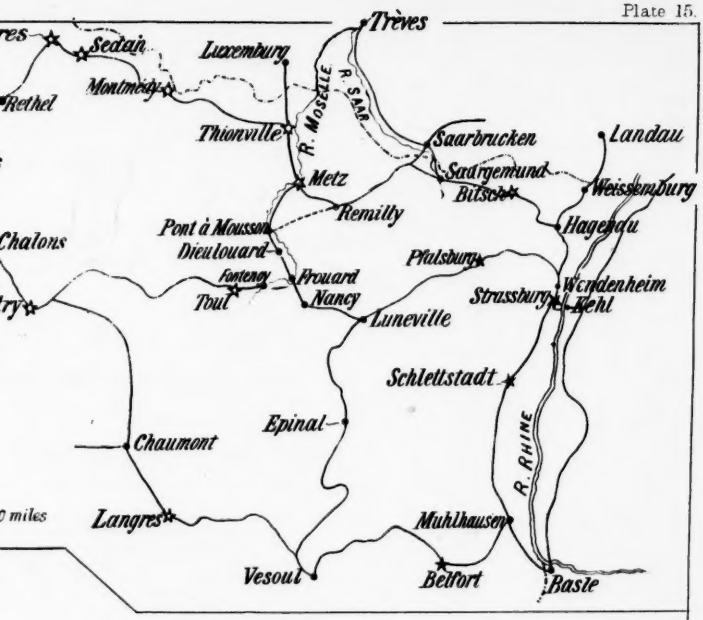
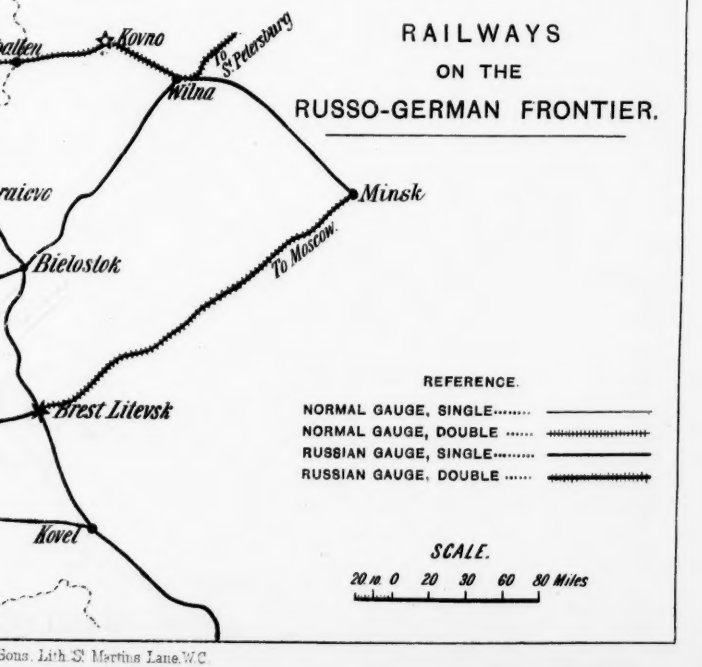




RAILWAYS ON THE RUSSO-GERMAN FRONTIER.

REFERENCE.

NORMAL GAUGE, SINGLE.....

NORMAL GAUGE, DOUBLE .....

RUSSIAN GAUGE, SINGLE.....

RUSSIAN GAUGE, DOUBLE .....

SCALE.

20 m. 0 20 30 60 80 Miles

Sons. Lith. St. Martins Lane. W.C.

an alternative route if this were blocked, or in cases where a line is guarded by a fort, how this might best be attacked; but the special object of the reconnaissance would usually indicate the points requiring peculiar attention.

Utilization of Railways.

We may now pass on to a consideration of the utilization of railways in war; and, as in civil life railways afford the means of conveyance for passengers and for goods, so in war do they provide for the conveyance of troops, and for the conveyance of stores.

As the subject of the conveyance of troops by railway has been recently discussed by me in the pages of a military periodical,[1] I do not propose on this occasion to refer to it at length; but it may be observed that the great value of railways in this point of view is the power which they give of concentrating very large forces at a place of strategical importance with certainty and rapidity. In former days, when such concentrations had to be effected by long and toilsome marches, troops intended to take part in them had to be set in motion weeks or months before the appointed time; but now the same distance can be covered by the help of railways in a day or two, and the hour for the arrival of each unit can be accurately laid down.

Railways may be used, as they were in 1866, for transporting large forces from one theatre of war to another in the course of the same campaign; but the circumstances under which their strategic value would probably be most conspicuous would be where one Power is engaged in hostilities with two other Powers whose railways are not in connection. Thus, for instance, if Germany were at war at the same time with both Russia and France, she might first deal a heavy blow to one assailant, while holding the other in check; and then, by means of her railways, rapidly bring a preponderance of force to that side where before she had been weakest.

In tactical movements of troops, railways have not yet taken an important place. They were used in a few instances during the Franco-German war for bringing up troops to take part in an action, but the opportunities for employing them must be rare, and no change in tactics has been brought about by the possibility of utilizing them.

When, however, we examine the question of the utilization of railways for purposes of supply in war, we find that their importance is very great. They permit operations to be undertaken which under the old conditions could not have been thought of, by enabling large armies to remain concentrated for long periods at a time. Under the old conditions, even in rich countries, it was impossible to avoid a greater or less dispersion of the Army Corps, Divisions, or Brigades for convenience of supply, and it was only on the eve of a general action that the Army was united. But in the Franco-German war

[1] See paper by Colonel J. S. Rothwell, "United Service Magazine," December 1891, and January, 1892.

we find German armies of great size engaged in the sieges of Metz and Paris, and it is quite certain that if the besiegers of the latter had not been able to utilize railways for supply purposes, they must have been starved out themselves.

In the Crimea, with sea transport to within a few miles of our camp, we learnt a good deal on the subject of the difficulties of supplying an army while it remains stationary in an exhausted district, and in these days, when the wants of an army are greater than they were forty years ago, it may confidently be predicted that when the line of communication is long, no siege on a large scale can be undertaken with any hope of success, unless the besieger has good railway communication to within a short distance of his camp and batteries.

There are two principal means by which a hostile force may be debarred from utilizing the railways of a territory which it has invaded, that is to say, by fortresses, and by the demolition of the lines. In the case of the German movement on Paris, the route by Saarbrücken was effectually blocked by the fortress of Metz, which also guarded the northern line through the Vosges by Hagenau and Saargemünd, while the southern route was similarly barred by Strassburg, Schlettstadt, and Belfort; but the central route through the mountains by Saverne was protected by no defensive works, as it branched off before reaching Strassburg, and passed fully 2 miles from the fortress of Pfalsburg, while in the whole extent from the Vosges to Paris it was only guarded by the fortresses of Toul and Vitry.

Vitry made no resistance, and when Toul was captured, on the 23rd September, the Germans had little difficulty in making the line available, at first to Nogent l'Artaud, near Nanteuil-sur-Marne, about 40 miles from the line of investment, and afterwards to Lagny, by which the road transport was reduced to 9 miles. The German Army before Paris, which was over 120,000 strong when the city was first invested, and was afterwards increased, was thus almost entirely dependent for its supply on one line of railway, which for a length of nearly 300 miles passed through hostile territory.

As it was quite impossible to watch the whole of this long line, the German system was to guard the most vulnerable points, such as bridges or tunnels, and, when any damage was done, to inflict the most severe punishments on the offenders. By the regulations in force, any person caught in the act of injuring a railway or telegraph line was brought before a Court-martial, which was not authorized to inflict any other sentence except instant death; and the commune to which the offender belonged and that in which the outrage occurred were each fined to the full amount of their annual taxation.

But as there was always a possibility of serious damage being caused, either by a pre-arranged "accident" or by means of some concealed mine, placed beneath the rails so as to explode on the passage of a train, it was customary to "invite" one of the most influential inhabitants of the town to accompany each military train;

and these gentlemen, who from one town such as Reims were sometimes as many as twelve per day, were either obliged to travel on the engine, or, under more favourable circumstances, were allowed to occupy a compartment with the German Officers.

Traffic over the hostile lines being thus secured so far as was possible, trains could be made up at some far-away German station, and a continuous stream of traffic could be sent direct to the spot where the supplies were required, while the same direct communication was equally advantageous in removing sick, wounded, and prisoners from the Army in front, and in distributing them to the places in the home districts where they could be conveniently disposed of.

Such a system, however, is only possible where the gauge of the railways of both States is the same. If the lines of the two countries have different gauges, it is hopeless to try to accommodate the rolling stock of one to the other. Attempts have been made with shifting axles, or by lifting the superstructure of loaded wagons on to a set of wheels of the new gauge, but no very satisfactory results have been arrived at; and in any case, even if wagons could be so treated, the locomotives could not be made interchangeable. It follows, therefore, that wherever there is a break of gauge, the military force which proposes to utilize the railway beyond this point must adopt one or other of two alternative courses: either a great depôt must be formed at the point where the break of gauge occurs, and where all freight must be transferred to vehicles capable of running on the advanced section of the line, or else the gauge of this section must be altered so as to enable the rolling stock of the home railways to traverse it.

Where the change of gauge occurs on the frontier between the two contending States, the objections to the first course are manifest. The invading army can seldom hope to secure a large quantity of rolling stock in the country invaded, and thus, while the army in its advance would be ill-supplied, there would be at the frontier a vast accumulation of stores, which, in the event of a reverse, would be liable to capture. The best course to be adopted under such circumstances would, therefore, be a conversion of the gauge to suit the invaders' rolling stock.

It has been mentioned already that the principal European States which have not adopted the normal gauge are Russia and Spain; and if ever hostilities should break out between Russia and Germany, this question of the difference of gauge will have considerable prominence. The gauge generally adopted in Russia is 5 feet, but on most of the lines on the left bank of the Vistula the gauge is the same as in Germany. If then Russia proposed to invade Germany through Poland, she would have the advantage of the break of gauge occurring well within her own territories, and not on the frontier, and she would also be in possession of a certain amount of narrow-gauge rolling stock. But, if a Russian Army were to invade East Prussia, the break of gauge would here occur on the frontier, and Russia would find before her the two alternatives mentioned just now; that is to say, she must either re-arrange all the transport at the frontier

stations, or alter the gauge of the German lines to suit Russian carriages.

In the event of a German invasion of Russia, the conditions for railway transport would be more favourable to the invaders than in the case where the Russians invade Germany. If Germany should invade that part of Poland lying west of the Vistula, the question of a difference of gauge will not arise, except for a movement against Ivangorod from Southern Silesia. A German force, however, operating from East Prussia against Kovno or the eastern portion of Poland, or the main German Army endeavouring to push on east of the Vistula, will at once meet with the difficulties connected with a break of gauge, and it appears most probable that these difficulties will be overcome by making the gauge of any Russian line which may be occupied capable of carrying German trains; that is, by reducing the distance between the metals from 5 feet to 4 feet $8\frac{1}{2}$ inches. This is a sufficiently easy operation, as the Russian lines are laid on the plan generally adopted on the Continent, of fixing Vignoles rails by pins direct to the sleeper without any chairs being used, and it has been proved that the shifting inwards of one line of metals for a space of $3\frac{1}{2}$ inches can be performed quite as rapidly as an army is likely to advance, *i.e.*, at the rate of about 12 miles per day.

The converse operation of widening the gauge by $3\frac{1}{2}$ inches, which the Russians would have to carry out in order to utilize the German lines in districts which they might have invaded, would probably be much more difficult; for, though there would presumably be sufficient length of sleeper to allow of the change in the position of one rail, it does not follow that the wider vehicles would be able to pass the bridges and tunnels which have been constructed merely to accommodate those of the narrow gauge.

It thus appears that in those cases where a State such as Russia or Spain has deliberately chosen a gauge for its railways wider than that used by its neighbours, it does not thereby secure immunity against invasion. The Power with the narrow-gauge railways can, with a little trouble, utilize any of the broader-gauge lines which may be of service to its invading troops, while, on the other hand, if the Power with the broader gauge should become the invader, the narrow-gauge lines which its army would find beyond the frontier might be of comparatively little value.

In our own case, as has been mentioned already, there are but few places where we connect with the railways of another State, and in these particular instances there is no break of gauge; the American lines connecting with those of the Dominion of Canada being, like the latter, of the normal 4 feet $8\frac{1}{2}$ inches gauge, while throughout South Africa only one gauge has been adopted, viz., 3 feet 6 inches.

It is somewhat remarkable that while the group of Colonies and States in South Africa have thus agreed on an identical gauge, greatly to their mutual advantage, no such uniformity is to be found in our Australian Colonies, where South Australia and Victoria have adopted the 5 feet 3 inches, or Irish, gauge, New South Wales the

normal English gauge, and Queensland the 3 feet 6 inches gauge. These lines are all now in connection, but their military value, as a means of rapidly reinforcing a threatened point by troops from a neighbouring Colony, is considerably reduced by these breaks of gauge.

In India this same question of the break of gauge has been the subject of much controversy, and is of serious military importance. Indian railways have been, and may be, utilized for military purposes on a scale of which we have had no experience in this country, and in any large movement of troops there, made under the pressure of actual or impending war, the fact that two distinct gauges exist is likely to make itself felt injuriously. It is true that the great strategic lines are laid on the 5 feet 6 inches gauge, but many of the secondary lines, which might have considerable importance under such conditions, are laid on the metre, or 3 feet 3·37 inches, gauge, and these secondary lines are scattered over different parts of the peninsula, and are not in connection with each other. Even in countries where the gauge is uniform, it has been found that the main difficulty in the way of utilizing railways for military purposes is either that the supply of rolling stock of a particular description is deficient, or else that the rolling stock required is not at the place where it is wanted, and it is hardly necessary to observe that in a country which possesses two railway systems with different gauges this difficulty is likely to be intensified. If all the railways in the plains of India had been of the same gauge, even though some were of less solid construction, like certain of the "light railways" recently laid in Ireland, the military advantages would have been very considerable, and the cost of construction, according to a high authority,[1] would have been little greater than that for metre-gauge lines. These light lines might then, in some cases, have afforded an alternative route between important centres, and this route, even if it were not directly utilized for the transport of troops or stores, might have been of great convenience in sending back empty rolling stock, while, in other cases, such lines would have permitted rolling stock to be transferred from one district to another, according to the requirements of the transport service. As it is, however, the two systems are absolutely distinct, and for military operations on a large scale the one can afford but little help to the other.

Reference has already been made to the gradual approach of the Russian and Indian railway systems, and it may be observed that, as the line which we have now pushed on through the Kojak tunnel to New Chaman, 72 miles from Candahar, has been constructed on the 5 feet 6 inches gauge, it follows that, if this railway ever joins the Russian line of 5 feet gauge, any advantage which may be connected with the difference of gauge will not be on our side.

Before quitting the subject of the utilization of a railway in war, there is one other point which may be mentioned, viz., the employ-

[1] J. Wolfe Barry, Esq., C.E.

ment of a railway as a road for the march of troops. Short sections of a line may be used in this way, as where a railway affords the best or only means of crossing a river or a morass, but except for infantry, or small bodies of cavalry, a railway is so much inferior to an ordinary road that it is not usually to be counted on as a means of communication.

Destruction of Railways.

It now remains for us to consider what is called the "destruction" of a railway in war, and it may be incidentally observed that this term, though in general use, is extremely inaccurate. No railway has ever ceased to exist in consequence of injuries inflicted on it in time of war, and though its traffic may be suspended for a longer or shorter time by reason of those injuries, it would be quite as logical to say that a soldier who goes into hospital with a broken arm is thereby "destroyed" as to apply this term to a railway which has had some of its rails and sleepers removed. The term, however, has been so generally adopted, both when the damage is of a nature which can be repaired in a few hours, and when it is so serious as to render the line useless during the remainder of the operations, that we must continue to employ it.

Between the two extremes thus indicated, there are numerous measures, of greater or less efficacy, which may be taken to prevent an enemy from making use of a particular railway at a particular time. As regards the permanent way, a good deal depends on the manner in which it is laid, but a length of the line may be taken up, a large fire made with sleepers, fences, and dry wood, so as to heat the rails, which, being laid on top, are then easily bent out of shape. If, while hot, the rails are twisted, in addition to being bent, they cannot again be used without being passed through the rolling mill.

In cases where the line is double, an interruption to the traffic thus caused would not be of long duration, for if a gap, even of a mile, was found to exist in the permanent way, it would not take long to take up a similar length of one of the lines of way, and relay it at the place where the gap has been made, the line being worked as a single line until an opportunity occurs for restoring it completely.

On single lines, however, especially if the place selected for attack is on a curve, and if the materials for repair have to be collected and brought from some distant point, the time which may elapse before the line is again in working order might be so considerable as to produce important results, and, in 1870, the Germans adopted the plan of keeping trains ready, laden with rails and sleepers, at certain central stations in a district where the line was liable to attack, so that they might be dispatched with the least possible delay, when an injury to the line was reported. It is now stated that the Germans propose in future, under similar circumstances, not only to keep ready rails and sleepers, but also to have at hand the means of bridging culverts or any small openings which may have been made in more important works.

The destruction of the buildings at a station is generally of little

use, but much mischief may be done in a short time by a raiding party who devote themselves to cutting the telegraph wires, breaking the telegraph instruments, removing points and crossings, and destroying the arrangements for the supply of water. This matter of water supply is one of first-rate importance to a railway, as any section which has been completely deprived of the means of watering engines is, of course, useless for the time; and if the tanks, water-cranes, and pumps have been effectually destroyed, it will generally take a considerable time before any heavy traffic can be sent over the line.

Other injuries to a railway may be caused by cutting through an embankment, or by blowing in the sides of a cutting, or the end of a tunnel, but the time which will be required for re-establishing the traffic under these circumstances will principally depend on the amount of labour to be obtained, on the nature of the soil, and on the facilities for working at the removal of the obstruction from both ends simultaneously. For a lengthened interference with the traffic, however, nothing can compare with the blowing up of a lofty viaduct or the overthrow of a long girder; but the destruction of such works as these should never be attempted without the express order of the General Commanding the Army.

In all cases, the measures which are to be adopted for interfering with railway traffic must be dictated by the military situation at the time, of which the General in Command alone can judge, but the circumstances under which such interference might be necessary will generally be comprised in one of three cases, which may be stated as follows:—

1st. On the outbreak of war between two States, each will try to destroy the railways of the other, in order to hinder the mobilization or movement of his troops.

2nd. A State which finds itself invaded, or liable to immediate invasion, may destroy its own railways, to prevent them being of service to the enemy.

3rd. A state which has been invaded will try to destroy its own railways, when they are being used by the invader as a means of communication.

The first case resolves itself into a series of cavalry raids across the frontier during the period of mobilization and concentration, and the damage done will probably be confined to a removal of the rails or the destruction of some small bridge. While it is uncertain who is to be the invader, the raiders would do nothing to interfere with the permanent efficiency of the lines which might afterwards be required by their own side, and for this reason, as well as for their greater accessibility, it is usually the lines which run parallel to the frontier that become the objects of attack, while those which lead towards the heart of the enemy's territory are left unmolested.

In 1870 there was a line of railway which in the early days of the war was the scene of several attacks. This was the line from Hagenau to Trèves, which ran nearly parallel to the frontier the

whole way, the eastern section being in French territory, and the western in German. The German section was covered for the whole of its length by the Saar, while no such obstacle guarded the French section from attack, and this, in part, accounts for the fact that, while attempts were made against both sections, it was only the French lines that suffered any damage. On the 24th July a party of the 7th Uhlans attempted to destroy the line between Saargemünd and Bitsch, at a place called Bliesbrücken, but they only managed to remove some of the rails, and the other attempts which were made at this period met with little success. As time went on, however, while the French cavalry showed little activity, the Germans continued to make raids across the frontier, and, as it was reported that the railway between Saargemünd and Bitsch was being extensively used for military transport on the 5th August, this line was attacked the same night and broken up in several places. The destruction of this railway had its effect next day, when the battle of Wörth was fought, as, if the line had been available, it might have been used to bring up the assistance which Marshal MacMahon counted on receiving from General Failly, and to the want of which the loss of that battle has been attributed.

Another instance of important results produced by an interference with the permanent way of a railway is afforded by the occupation of Pont-à-Mousson by the Germans, on the night of the 11th August, 1870. The transport of the 6th French Corps (Canrobert's) from Châlons to Metz was at this time in progress, but, in consequence of the Germans destroying the line at Pont-à-Mousson, Dieulouard, and Frouard, in the course of the 12th August, this transport had to be suspended. The 6th corps consequently reached Metz in a very incomplete state, several batteries of artillery, most of the reserve ammunition, and all the entrenching tools of the corps being left behind; and when it came to occupy the right of the French position at Gravelotte on the 18th, these deficiencies, both in personnel and matériel, became apparent in a very disastrous manner.

As regards the second case, where a State wilfully injures its own railways from fear of invasion, there was a remarkable instance at the commencement of the war in 1870; for the Germans, being apprehensive of an invasion of Baden by the forces assembled near Strassburg, blew up the swing bridge over the Rhine, at Kehl, on the 22nd July. As events turned out, the destruction of this fine work was quite unnecessary, and it was not till the middle of the following November that the communication by rail was restored at this point.

On the French side there was at first no apprehension of invasion, and, therefore, at the commencement of the war there was no suggestion of an interference with their own lines; but, when it became known that in Germany engineers were laying numerous mines for destroying portions of the lines in that country, the Eastern Railway Company of France suggested to the Minister of War that it would be wise to do as much on their own side of the frontier, especially for the purpose of blocking the cuttings and tunnels passing through

the Vosges mountains. The excavations for the mines were accordingly made by the railway company at spots approved by the military engineers, but no steps were taken either for charging them or for arranging when they were to be exploded. Even after the news of the battle of Wörth had been received in Paris, its strategic importance was not fully realized, and it was not till two or three days later that the orders for the destruction of the tunnels were issued. By this time it was too late, for the tunnels on the line by Saverne were already occupied and guarded by German troops.

The result of this omission was that any attempts which were made to obstruct the traffic were of a very trifling character, and German trains were able to run into the station of Nancy on the 21st August, three days after the battle of Gravelotte.

The line between Nancy and Paris had been damaged at various places, but all these were easily made passable with the exception of the tunnel at Nanteuil, some 40 miles from Paris. This tunnel had been destroyed by means of five mines, whose explosion had brought down the casing, and allowed a large quantity of fine sand to fall; and as it was found impossible to reopen the tunnel in consequence of a further fall of sand, caused by heavy rain, the Germans were forced to make a loop line to connect with the main line beyond the tunnel. This loop line, which was about 3 miles in length, was not completed till the 23rd November, so that a delay of nearly two months was caused by this demolition.

There now remains merely the third case which has been mentioned, viz., the attempts made on lines which are being utilized by an invading army. We have already referred to the repressive measures adopted by the Germans, but, in spite of these severe penalties, Frenchmen were always to be found ready to hinder the traffic by pulling up the permanent way, or by even more adventurous enterprises. An instance of the latter class occurred on the line between Frouard and Toul, which, as we have seen, formed part of the main line of communication for the German Army investing Paris. In this section of the line, at Fontenoy-sur-Moselle, the railway passes over the Moselle valley by means of a fine viaduct of seven masonry arches; and on the 22nd January, 1871, the German troops who were guarding it were overpowered by a body of Frenchmen—called by the Germans franc-tireurs, but according to French accounts entitled to be considered belligerents—who thus obtained temporary possession of this portion of the railway. When the viaduct had been constructed, a chamber had been formed low down in the easternmost pier, and this was now charged and exploded, with the result that the pier and two of the arches were brought down, while the rest of the viaduct remained intact.

The gap which was thus formed was too wide to be bridged over with such materials as were available, and the Germans therefore decided on making an embankment in place of the arches which had been destroyed. This work was accomplished in seventeen days, during which time all traffic on the line was, of course, suspended; but this interruption was less felt than it would have been previous

to the fall of Metz and the northern fortresses of Thionville, Montmédy, and Mézières, as this route was now available for the supply of the troops before Paris.[1]

From the difficulty experienced in re-establishing the communication across this broken viaduct, it is very doubtful if it could have been successfully accomplished supposing the mine had been exploded in one of the centre piers instead of in the one next the bank, and in the improbable event of our Engineers having to prepare a chamber for a similar purpose, the experiences at Fontenoy-sur-Moselle may be instructive.

The irritation of the Germans at the destruction of this viaduct was very great. The village of Fontenoy was burnt, a fine of ten millions of francs (400,000*l.*), to be paid within eight days, was demanded from the province of Lorraine, and on the day following the act, the Mayor of Nancy was informed that, unless 500 workmen were ready at the station by noon on the 24th, all factories would be closed, all public works suspended, and, in the first place, the superintendents, and afterwards some of the workmen, belonging to the factories in the town would be shot. It is, perhaps, needless to add that the working party required was ready at the time appointed.

Conclusion.

This examination of the reconnaissance, utilization, and destruction of railways must now be concluded. While we may feel confident that the reconnaissance of lines that are of military importance to us has not been neglected, and while we may hope that well-considered plans for the utilization of our railways in time of war will be ready whenever an emergency may arise, our most patriotic aspiration is that the course of any military operations on which we may be engaged will never take such a turn as to lead to the destruction of a single yard of a British railway.

Captain H. Huleatt, R.E.: I hope Colonel Rothwell will forgive me if I differ with some of his conclusions. I want to take exception to the first paragraph of the paper; that is the one in which he says "it is rare in this country to find any Officer who has had experience in executing a reconnaissance of a railway." I think when he wrote that he must have forgotten my own corps, because it is part of the course at Chatham that every Officer shall be instructed and practised in making these reconnaissances. It was so when I went through, and I believe it still is the case, that every Officer makes a general reconnaissance of a piece of line. Afterwards he is given a piece of railway for the destruction of which he has to prepare plans, and then some other Officer has instructions given him to show how the line when so destroyed can be again utilized. I think, therefore, I may say that we are practised in making these reconnaissances in peace-time, and all the instruction for it and the information necessary is laid down in our text-books. Besides that there are a very large number of Officers employed on railways in India, and they gain experience of all sorts of railway work. We have two railway companies at home, and a great deal is done to instruct them in this work. Dealing with railway reconnaissances as a whole, Colonel Rothwell gave us one

[1] Mézières, the last fortress blocking this route, had capitulated on the 1st January, 1871.

list of details that we are to observe practically under most circumstances. I was in hopes before I read the lecture that Colonel Rothwell would have divided it rather more and have distinguished between three different sorts of reconnaissances to be made of railways. There is first the general reconnaissance to get all the information possible, and that would be made before the outbreak of hostilities if possible. Then there is the reconnaissance simply with the view of destroying a railway. And, thirdly, there is the reconnaissance of a railway which it is desired to utilize after repairing it, if necessary. I think it is apparent that the kind of reconnaissance to be made would be very different in each of these cases, that we should observe and record different particulars in each of the three cases, and it would be very desirable to have them laid down. For instance, you might take the case of a stock of coal; if we were going to utilize a railway it would be most essential to know what stock of coal there was in a particular place, but if we were going to destroy the railway it would not matter much. If we were taking a general reconnaissance of a railway some months before we were going to use it, the existence of a stock of coal there would be no guarantee that it would exist when we came to want to use the railway. So that I think these three classes of reconnaissances should be kept distinct, instead of being lumped together as they generally are. Then as to the details given. I believe the definition given of "permanent way" is not a good one. I am not speaking on my own authority, but I think that, although it is correct, as far as it goes, it is liable to be misunderstood. "Permanent way" ordinarily includes only the actual rails, sleepers, and their fastenings, such as fish plates, fish bolts, spikes, chairs, and so on, and possibly ballast. In no case does it include bridges or embankments, as might have been thought from the definition given in the lecture. Then as to observing the details of the permanent way, the form of chair was mentioned in the lecture but not the form of rail. I think it is very much more important that the actual form of rail should be noticed and its connection than the form of chair, because it gives us a guide to the weight of the permanent way. If we know the rail we can make some other chair to suit it, whereas the form of chair is really of very little importance. Another thing of more importance is the dimension of the spikes and bolts; it is very awkward to find yourself with inch bolts when everything has only $\frac{3}{4}$ or $\frac{7}{8}$ holes. Then, as to the gradients, I understood from this lecture that we were to observe all gradients, to see which way they fell and to get a great many details about them. I do not think it is the case in all foreign railways that the gradients are marked, so that this would involve a great deal of labour, and it does not appear to serve any useful purpose. It seems to me that if we knew the severest gradient in each direction that would be amply sufficient. It might be desirable to observe two or three of the severest gradients, but I cannot see any reason for observing the minor gradients; it appears to me to be a waste of labour. There is one point missed out that is really of very great importance, and that is observing the smallest curve. Supposing we have to bring rolling stock from a different railway, as has been done once in my experience, this is a very essential point. On the Nile, for instance, we brought rolling stock from the Cape, and it might happen if we brought rolling stock from a straight railway on to a curved railway it would not run. It is, therefore, very essential to notice the smallest curve. It is very easy to measure on the ground. All that has to be done is to stretch a 50- or 100-foot tape across the curved rail so as to form a chord of the arc, and notice the distance between the centre point of the tape and the middle point of the curve and the radius can be worked out. Then as to locomotives. I think it is scarcely possible that they could be fully examined in any reconnaissance as ordinarily understood, that is, in any reconnaissance done in anything like limited time. If a locomotive is obviously broken down it is easy for any Officer who has worked on railways to say that the locomotive could not work, but the locomotive might be apparently perfect and yet it would be quite impossible to say whether it would work without getting up steam, and trying the locomotives under steam would take a considerable time. But I think if steam was up, many Officers would be able to ascertain whether it would work or not, and what repairs were likely to be required. Then the lecturer does not mention the height of the floor of the trucks. It is a very essential point in connection with

platforms, gun ramps, &c., that we should have the height of floor above the level of the rail. Also with regard to the wagons, the way in which they open should be ascertained. If possible, in the case of a reconnaissance of the third-class where one is going to utilize a railway, it would be very desirable to know in what condition the wheels and axles, and the arrangements for lubrication, were; that would make a great deal of difference when we came to run them. Then there is the question of break of gauge, and this is a very complicated question, and almost deserves a lecture to itself. I am bound to say the conclusions I came to after careful consideration and study were exactly opposite to the conclusions of the lecturer; my conclusion was that it would be generally better to make arrangements for the transfer of freight from one gauge to another, rather than to narrow the gauge. I do not know how "it has been proved," that you can alter the gauge at the rate of 12 miles a day. I am rather in the dark as to what the proof is, but it appears to me unless it was a simple plain line of rail without any points and crossings, it would be exceedingly difficult to go at that pace. We make a great many points and crossings in Woolwich Arsenal, and I do not think it would be possible to alter each set of points and crossings from one gauge to the other in less than half a day at the least. To do it you would want a gang of about ten very highly trained men, and you would be lucky if you could do it without having to put the rails on a machine. Of course the straight part of the railway would be of no use unless you could alter the junctions and passing plates. Then, again, it often happens that on a large bridge, or long viaduct, the rails are laid in troughs, and it would be necessary before narrowing the gauge to raise them out of the trough, and you would have to block them up in the trough, and that would involve altering the gradient. I think the time required would be very much longer than that given in the lecture: it would require a very large number of men not always easy to get, and a great proportion must be skilled railway workmen. No doubt it would be easy on our own lines, but I doubt whether we should get the necessary number of trained railway workmen in a hostile country unless we brought civilians with us from England, and that has not always been a success. Another point which would affect the question very much is the comparative length of the lines of the two gauges required to be used. If the piece to be altered is 12, or 30, or 50 miles, it might be worth while narrowing the gauge, but, supposing you are hoping to run over the whole country, it appears to me it would be rather useless to begin to alter the gauge. It might be worth while altering the gauge to a town you are going to besiege, in order to bring up the heavy siege-train, but I do not believe it would be possible to follow a field army. Directly the General had to move off the line prepared, the railways would become useless, whereas if you had made arrangements to get rolling stock, wherever the railways of the country ran, you could follow the army with your trains. Supposing you capture your town, any rolling stock you might acquire would be useless if you altered the gauge, whereas it is a great gain if you are going to use the lines as they are. I believe the Germans captured somewhere about 16,000 wagons in Metz, and if it had been a case of altering gauge, they would have been no use whatever. Then, also, supposing your lines are laid with steel sleepers, you cannot alter the gauge, or at least not without much heavier labour. If, on the other hand, you make a transfer station, you have the advantage of doing your work in territory which is comparatively safe from interruption from the enemy. You are able to employ unskilled labour instead of skilled labour; and once you get your stores on the truck it can go anywhere over the country that you are attacking. It has very often been done. It is quite possible to imagine that even if we could not capture rolling stock immediately on the frontier with our Fleet, we could capture rolling stock at some other parts of the country and bring it round. In the war of 1882 we captured rolling stock at Alexandria and took it round and put it on the rails at Suez. We found very little stock at Ismailia when we arrived, but we brought locomotives round, and used them. Then there is one more point on the question of the utilization of railways, and that is what the lecturer says about not using a railway as a road. There I agree with him thoroughly, but I go a great deal further. Not only does a railway make a bad road for troops, but the passage of troops is very bad for the railway. I was in the Railway Company in 1882. We

had to meet many difficulties, but I do not think there was anything more heart-breaking than to find the little heap of sand which had been left on the rails by a cavalry regiment crossing, or by an infantry regiment having walked along the line. If you were lucky enough to see it in time, you had to wait while it was scraped away. If you were not lucky, you went over it and very likely one or more of your wagons came off the road. Between the 29th August and the 14th September, we had six accidents due to troops crossing the line—absolutely directly due to that without any other cause. I do not know what the amount of delay was; it was impossible to estimate it, but I can vouch for the fact of its having taken place. We were fortunate enough not to damage our engine in any case, but, supposing an engine had been disabled, the detriment to the carrying power of the railway would have been enormous. Then there was another point with regard to the utilization of railways which was not touched on, viz., the question of not using railway trucks as store-houses. Nothing upsets traffic, diminishes the carrying powers of a railway, and disorganizes the work so much as the habit of loading trucks before people know where they are going to, and leaving them loaded after reaching their destination. I believe a great many of the French difficulties in 1870 were due to that. The capture by the Germans of so many trucks at Metz was due to mismanagement of different sorts, but one reason among others was that the French had a great deal of difficulty in working the traffic because all the sidings were blocked in with wagons. At the time of the fall of Metz there were no less than 7,500 wagons standing on one line of railways, the Paris, Lyons, and Mediterranean, loaded up and utterly useless, because nobody knew where the stores on them were intended to go to. It is a thing that does not depend only upon railway Officers, and the avoiding of this fault cannot be too strongly insisted upon in all discussions on the utilization of railways.

Admiral LONG: Though I am entirely unacquainted with all the details of railroads, it occurs to me there are one or two points in the very interesting lecture of Colonel Rothwell's about which I might say one or two words, to make the discussion more complete. Colonel Rothwell has not alluded to the possibility of railways being used for coast defence, which I believe is now one of the things that is contemplated. By placing quick-firing guns on trucks, they could be brought up to the scene of action very rapidly. And I think another thing we must remember is the possibility of an important part of a railroad being destroyed from the sea. We have now the Forth and Tay Bridges as conspicuous instances in this country, and there are several places both in England and Italy, and, I think, in France and Spain, where railroads run for some distance near the coast. I have lately been reading a work treating of the possibility of destroying coast towns, in which it is pointed out that explosives may be thrown in very readily by cruisers. I think that portions of a railroad might very likely be destroyed from the sea in that manner. We read that in the Peninsular War some of our ships did very great service by obstructing the passage of French troops along roads. The frigates used to lie off them, and if they saw anybody going along fire at them, which was found to be a very great obstruction.

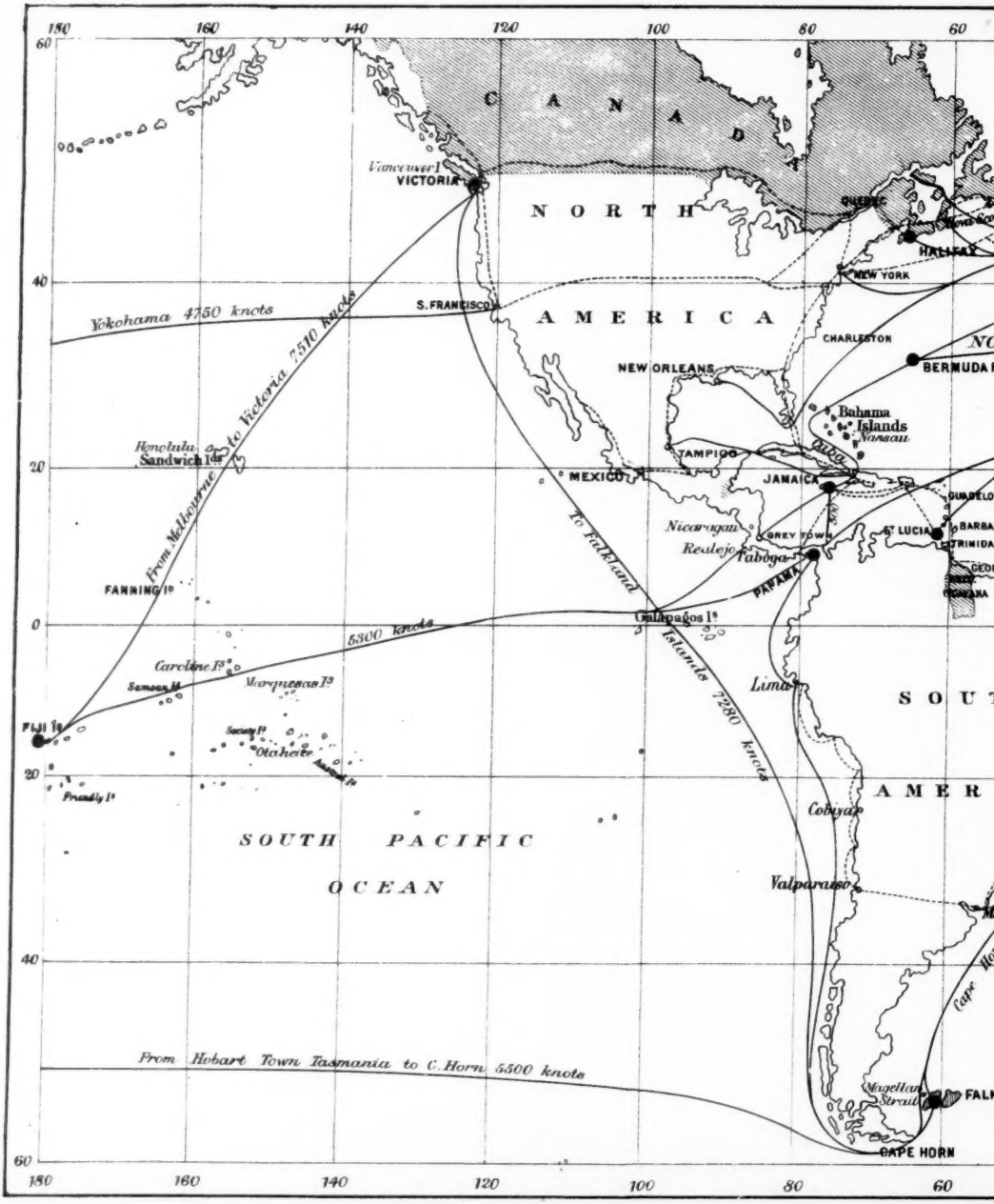
Captain GRIERSON, R.A., D.A.A.G., Intelligence Branch, War Office: In the beginning of Colonel Rothwell's lecture he said that the reconnaissance of a railway could not be accomplished from a train. No doubt a detailed reconnaissance of a railway cannot be accomplished from a train, but there are many cases in which you have to do it in that way. In work in connection with reconnaissance abroad, it is in many cases impossible for various reasons to go along the railway and make a reconnaissance on foot. It is, therefore, of great importance that we should practise the reconnaissance of railways from trains. A great deal can, I think, be done in that way. You have guide books, you know the distance between the stations. By the use of your watch and time tables you can tell the rate the train goes at, and by noting where the bridges are passed you can arrive at an idea of their position, which can be checked afterwards by maps on a large scale. Moreover, by craning out of the window you can see the bridges, and you can occasionally look back along curves, and in that way certain points of very great value can be noticed from a train. In a great many foreign countries the trains, as I think we all have had reason to remember, go very slowly and stop a long time

at a great many stations. During those stoppages there is ample time for measuring platforms, counting the number of sidings, and making notes generally upon the stations. I think Colonel Rothwell's lecture has brought out the enormous importance that ought to be attached now-a-days to the larger development of railway troops. Since the last war this development has been very marked in all countries of Europe. I am not quite certain whether the Germans had any railway troops before the war of 1870, but certainly very shortly after that war they formed one railway battalion. That has since been expanded into a brigade of four battalions, and the Bavarian Company has been expanded into a small battalion of two companies. In war these would undergo a most enormous development; they would be expanded to something like four times the size. The same has been done in every other country. Russia works her Trans-Caspian Railway entirely by railway battalions. Railway battalions made that railway, and work it actually in peace. Russia also has a railway brigade, which is stationed at the important railway junction of Baranovichi, and is constantly trained in the construction and working of railways. Other nations are also largely developing this most important branch of modern armies. The reason of that seems to be that armies in the future will be so enormous that they will eat up a country like a swarm of locusts, and the supply must be entirely by railway. Naturally the railway employés, and, as far as possible, the rolling stock, will be withdrawn as the enemy retires, so that the invaders of the country will have to find the personnel. We know how hopeless it is to attempt to repair a railway—I won't say hopeless, because difficulties are only made to be overcome—but how difficult it is to construct and work a line in a theatre of war by civil personnel and labour. The advantages of having a military organized body of railway troops were apparent to every one who was at Suakim in 1885, and saw those undisciplined and disorderly navvies attempting to construct a railway. I think no further proof is required that we must have railway troops under military control, under the head of the Army. Civilian labour must be under military command, and the whole thing must be worked in a military manner. I am perfectly aware we have done a great deal lately. Our Engineers have got railway companies, and arrangements have been made, I understand, though I do not know the details, for forming a reserve of railway men. One result of Colonel Rothwell's lecture, I hope, will be to direct attention to this very important question, because the circumstances in our wars are exactly the same as in other countries. We must in war rely on railways to a great extent, as we have done generally in the past and shall probably in the future; for whereas foreign armies go to invade hostile countries in such masses as to eat up the whole country, we go into countries where there is nothing to eat, and in both cases it comes to the same thing. I hope the result will be that attention will be directed to this point.

Colonel ROTHWELL: I am very much obliged for the kind way in which my lecture has been received. Captain Huleatt remarked on my having said that it was rare to find Officers in this country who had executed the reconnaissance of a railway. I may be permitted still to say that it is rare. Although the Engineers are all instructed in this form of reconnaissance, what I meant was that the number of Officers who have actually carried out a reconnaissance as a practical work is comparatively small. And, of course, I only spoke of Officers in this country, and not of those in India to whom he referred. I fully admit it would have been more convenient to have kept the different classes of railway reconnaissance distinct, but the size of the subject is so great that it was necessary to condense, as far as possible, the observations I had to make. In a report on a railway, Captain Huleatt says the radius of the smallest curve should be noted. I admit that this was an omission of mine; and I thank him for the correction. In most countries the height of the floor of the trucks would be the same, but where there is variation, the difference in height should come into the report. With regard to altering the gauge of a railway, Captain Huleatt did not agree with the view I took. My view was based on the observations of German writers, as the question is one that we are so little concerned with that I have not looked into it with regard to our own case. If we had to employ a railway in a foreign country, of a gauge different to our own, and took our rolling stock with us, we should very

likely take the rails too, and relay the whole thing. But the case has been very seriously considered by the Germans, especially with regard to Russia, which is the only country where the break of gauge would occur; and most of the German writers who have dealt with this question have given their opinion that the shifting of one line of rails would be the way in which they would meet the difficulty. Of course it would not be the case that Captain Huleatt referred to, of shifting the gauge of a whole country; it would only be of those lines which were used as lines of communication. Admiral Long spoke of the utility of railways for coast defence, and very likely they might be so used, if we were going to send a force to the coast to defend it. But in the case of an attempted invasion of this country, I cannot bring myself to believe that we shall try to defend the coast by a force sent down by rail; and I doubt whether we would send quick-firing guns, which would be certain to be overpowered by the guns of a fleet, which would cover any landing on these shores. The destruction of railways by ships of war is possible in many cases. For instance, on the shores of the Black Sea, near Batoum, I think the railway runs near the sea, and this might be a vulnerable point. Captain Grierson spoke about the possibility of reconnoitring from the train. I can only say that in travelling on the Continent, some years ago, I tried it for myself, and came to the conclusion that any results I obtained by craning out of the windows were not satisfactory. As to the development of railway troops, that is a matter that is going on extremely rapidly. I believe the German railway troops were first started on a small scale in the Danish War. Their value at the present day is very great indeed.

The CHAIRMAN (Sir Beauchamp Walker): I do not think I have anything to say in closing the discussion. I go a great deal on the old principle, *Ne sutor ultra crepidam*. I know very little about railways, and certainly shall not criticize my friend Colonel Rothwell. Admiral Long is quite right in speaking of the possibility of ships doing great damage to railways in Italy, because a great part of the Italian railways on the Mediterranean side run quite close to the shore, and are, therefore, exposed largely to fire. I was very much interested in hearing what Colonel Rothwell says about the Germans having developed the great question of how they are to act in the case of an invasion of Russia, because I perfectly remember before I left Germany, which is now nearly fourteen years ago, I had been told by Count Moltke himself, or by somebody very intimately connected with him, that there was only one subject on his mind as regarded the possibility of war between Germany and Russia, and that was the break of gauge. What conclusion he came to I do not know. Colonel Rothwell seems to know that there has been a good deal written on the subject lately, probably derived from some hints during his valuable lifetime. But I know that I heard him say himself, or the person who told me heard him say, "Thank goodness, I have got to the bottom of the question." He had evidently come to some conclusion which was satisfactory to himself. I think nothing further remains for me to do but to beg you all to give Colonel Rothwell a very warm vote of thanks for his lecture, and also to those Officers who have been good enough to speak in further illustration of it.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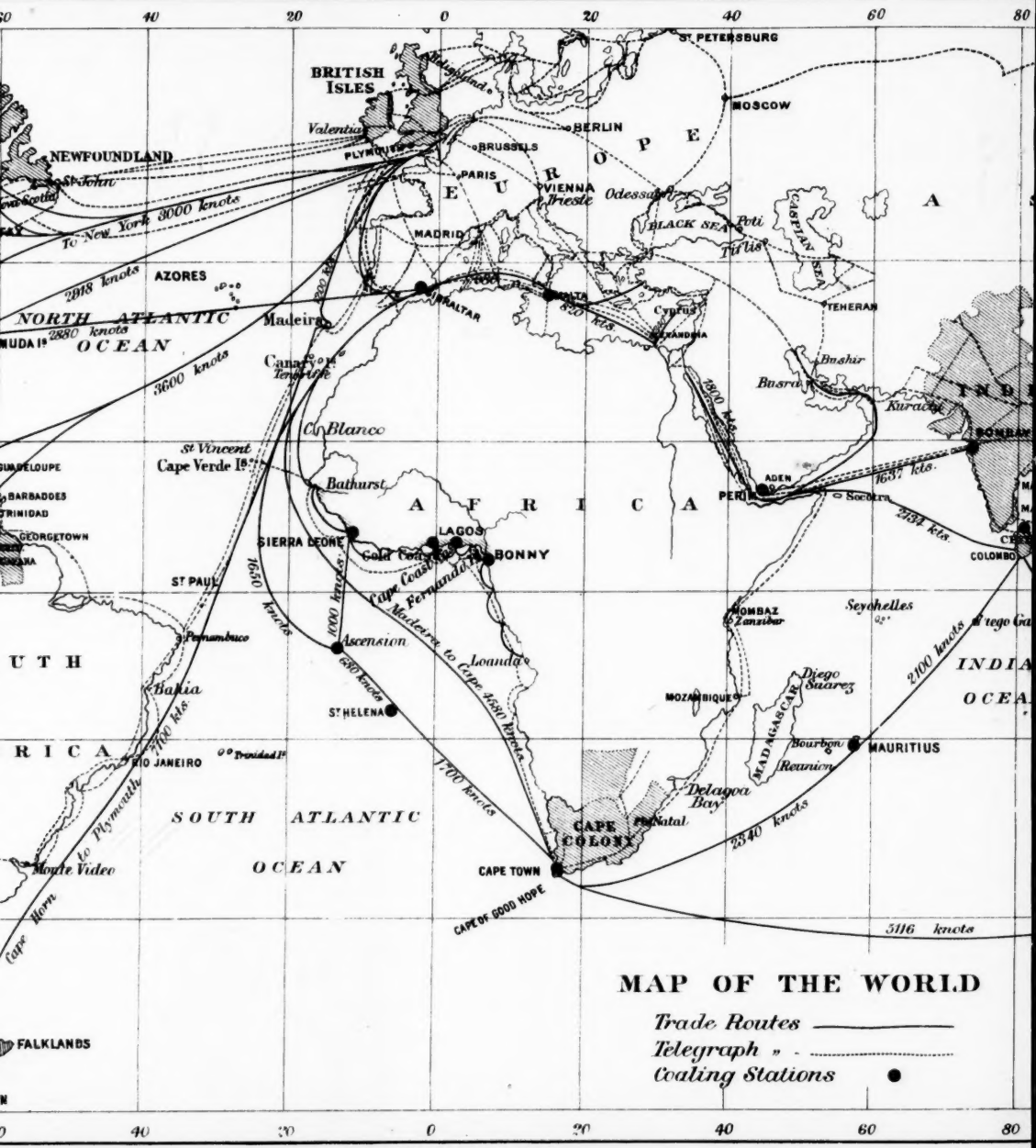

MAP OF THE WORLD

Trade Routes ———

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Coaling Stations ●

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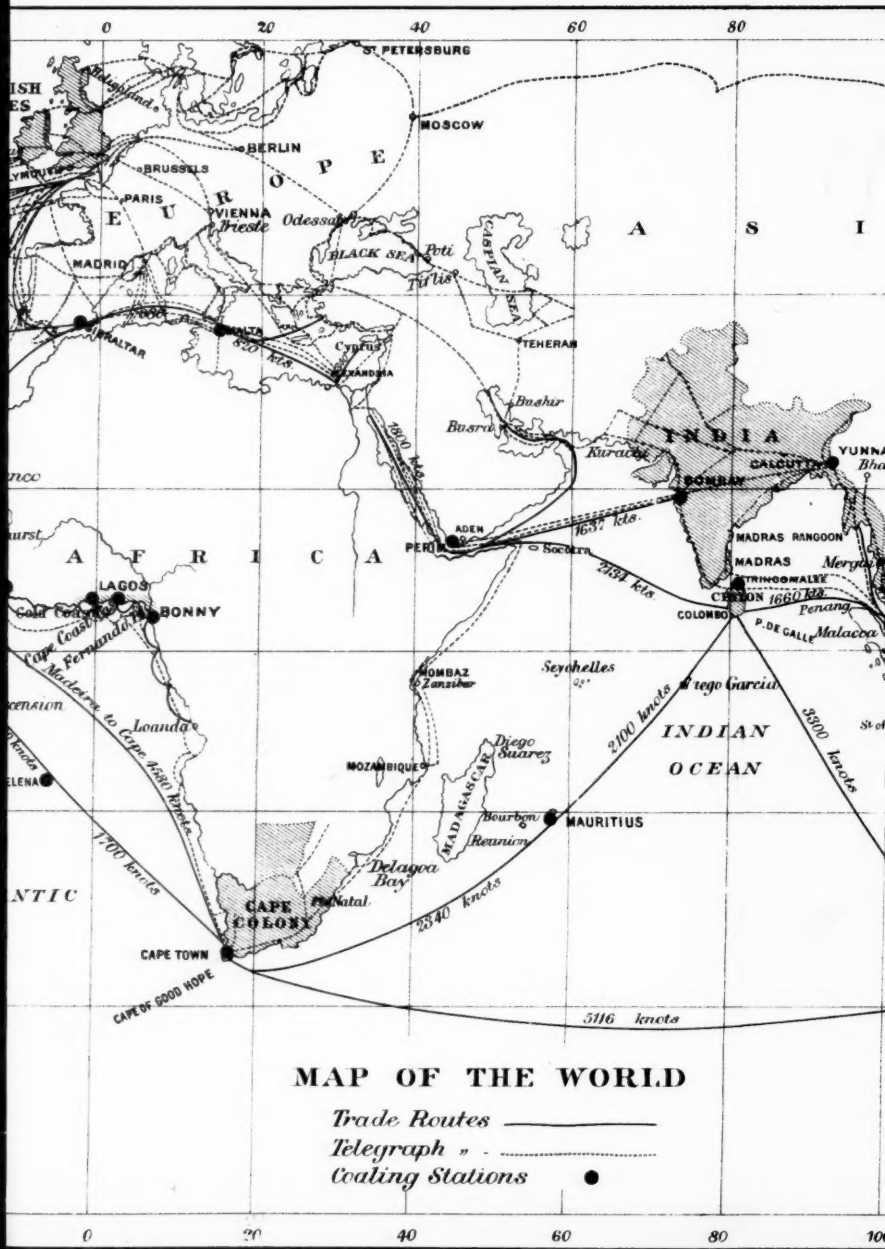

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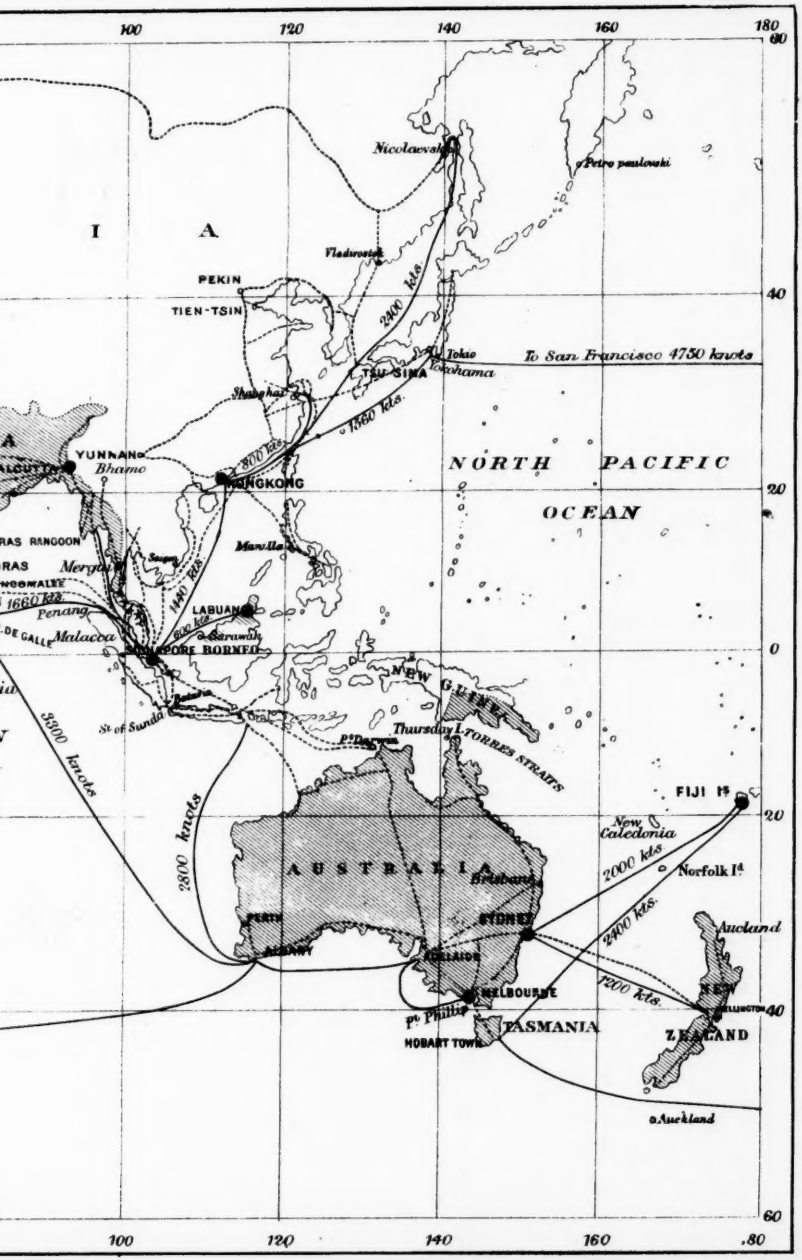
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Penang
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800 kts.
LABUAN
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Sarawak
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DE GALLE
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TORRES STRAITS
3300 knots
2800 knots
FIJI Is
New Caledonia
2000 kts.
Norfolk Is.
AUSTRALIA
Brisbane
PERTH
ALBANY
SYDNEY
ADELAIDE
2400 kts.
Auckland
1200 kts.
MELBOURNE
Pt Phillip
TASMANIA
HOBART TOWN
NEW ZEALAND
WELLINGTON
Auckland

NAVAL PRIZE ESSAY.

MARITIME SUPREMACY BEING ESSENTIAL FOR THE GENERAL PROTECTION OF THE BRITISH EMPIRE AND ITS COMMERCE, TO WHAT EXTENT, IF ANY, SHOULD OUR NAVAL FORCE BE SUPPLEMENTED BY FIXED DEFENCES AT HOME AND ABROAD, AND TO WHOM SHOULD THEY BE CONFIDED?

By Captain Robert W. Craigie, R.N.

"Ne sutor ultra crepidam."

Maritime supremacy can only be considered as a comparative term. Maritime supremacy may be termed relative as regards any one Power or absolute against the most powerful combination that is likely to assail us; for instance, to take a purely hypothetical case, that of France and Russia, so that the facts may be examined, France, being the most powerful maritime State next to ourselves, must always be considered when comparisons are made, which, indeed, should be taken as a compliment. Other things being equal, relative maritime supremacy can only be assured by a large preponderance of force; it has been laid down that for an efficient blockade the blockaders should have a superiority of at least one-third more in battle-ships and 2 to 1 in cruisers, but a reserve of battle-ships in the Channel would also be required, and also cruisers for the protection of the trade routes, so it may be assumed that to ensure a relative maritime supremacy over any one Power, a force of 2 to 1 in battle-ships and 3 to 1 in cruisers will be required.

As will be seen by Table A, we shall, in 1894, have such a relative maritime supremacy as compared with France.

For absolute maritime supremacy such a large preponderance of force is not required, because of the impossibility of two different Powers acting with the same unanimity, force, and energy as a single Power, and also on account of the scattered position of their bases; therefore, the proportion suggested as required in this case would be $1\frac{1}{2}$ to 1 in battle-ships and 2 to 1 in cruisers. On referring to the tables it will be seen that in 1894 we shall be 25 battle-ships short of this proportion, and it is a remarkable fact that France and Russia

are building together 26 armour-plated ships, while we are only building 10; it is evident, therefore, that if we wish to obtain an absolute maritime superiority we must make one more effort to do so by a well-considered programme.

The system of adopting a naval ship-building programme has proved wonderfully effective: the ships are built rapidly and cheaply, and a consistent policy is substituted for a shilly-shally; in fact, it is simply common sense, because ships cannot be built in a day, and our naval supremacy ought not to be the shuttlecock of political parties. The term of the programme should, however, be reduced to three years.

What extra force, then, is required to be built besides our annual tonnage required to keep up the Navy?

Of the 26 armoured vessels building by France and Russia, the 5 French cruisers may be considered as equivalent to unarmoured ones, the armour being so thin; this will leave 21. We shall then be only 18 short of the proportion of armoured ships, and as we can build so much faster than any other nation, 12 extra battle-ships will be quite sufficient to give us an absolute maritime supremacy over any two naval Powers, or 12 "Centurions" at a cost of 7,000,000*l.*

It is absurd to call the "Centurion" a 2nd-class battle-ship; in fact, our new 1st-class ones of the "Royal Sovereign" class are too big and too complicated, and there is a growing feeling against these unwieldy monsters, and their enormous guns worked only by machinery—a "box of tricks" as they have been well described. No truer words on naval warfare have ever been written than those quoted by Lord Brassey (p. 107) from a paper issued by the Naval Department of the United States: "Such a war, or one such battle, would prove what has long been the apprehension of intelligent Officers, that the war-ship of our day has become far too complicated for the people who may be called upon to work her; and that a balance of advantages, unsuspected by many, rests with that vessel which has comparative simplicity."

The premise of this essay, namely, "Maritime Supremacy," having been obtained by an extra effort, the subject, to what extent, if any, should our naval force be supplemented by fixed defences at home and abroad, can be considered under its two heads:—

(*a.*) General protection of the Empire.

(*b.*) Protection of Commerce.

However assured our naval supremacy may be, there is always a chance now in the days of steam of some portion of the enemy's fleet evading ours both at home and abroad; this has been clearly shown in recent manœuvres by the blockaded fleet escaping from Berehaven, in 1888, and by Admiral Seymour's squadron last year; but should the enemy approach British waters, our fleet would again be in touch with them through the intelligence system at the Admiralty, and it would be only a question of time for us to bring up a superior force to crush them, as shown by the manœuvres of 1889.

What then would be the limiting value of the portion of the enemy's fleet thus threatening our shores? There are three very

distinct and impassable limits to the offensive powers of this fugitive force pursued by a superior one, namely:—1, time; 2, coal; 3, ammunition.

As regards time, the outside limit to attack any one place in the United Kingdom can be taken as four days, for in that time a force could be sent from the Scilly Islands up either side of Great Britain and concentrated on any required point.

But would the enemy remain four days at any one place, expending his coal and ammunition, and knowing that then he would be certainly caught? No, the longest he would stay would probably be two days; so the question is, What damage could he do in that time? Would he land? The number of men available for landing purposes in a modern man-of-war are few compared to what it was in the sailing days, and though they might be accompanied by one or two troopers, with 1,000 to 2,000 men, there should be no difficulty in concentrating a sufficient force anywhere in Great Britain to drive them back, and in any case there would be a great risk to the enemy, since he is liable to be caught with all his men on shore. Would he bombard? Here again he is limited by his ammunition; how much would he be able to spare for bombardment in view of an imminent action with a superior force? It would certainly not be much, and might be computed as about twenty rounds per gun. We might safely say that a bombardment under these circumstances would not do much damage if proper precautions are taken to prevent fire and keep order. Would he confine himself to chasing merchant steamers? Here his limit of coal would be felt, and he would not have much to spare after a couple of days' hard chasing.

The result of this reasoning is that in all probability a squadron of the enemy's ships would threaten to land his men or bombard, but would do little else in the United Kingdom.

There is, however, another limit to be considered, and that is, what force an enemy would risk losing altogether, provided it had attained its required object? This must depend on the value of the object, and to estimate this the seaports of the United Kingdom are divided into four classes. (Table B.)

1. London and naval arsenals.
2. Commercial towns of the greatest importance, such as Liverpool and Glasgow.
3. Commercial and other towns, such as Bristol and Aberdeen.
4. Smaller towns with good harbours, such as Dartmouth and Falmouth.

London and the great naval ports of Sheerness, Dover, Portsmouth, Portland, Plymouth, and Pembroke are of such vast national importance that an enemy would be prepared to make great sacrifices in order to damage them seriously either by bombardment or landing; the limit in this case might be placed at one-tenth of their armoured force, or six battle-ships, with two transports containing 2,000 men. To meet a determined raid of this force it is evident that a fortress is required with armoured batteries, &c., with troops sufficient to meet 3,000 men, 1,000 from the battle-ships and 2,000 from the

transports, who might land and try to burn and destroy the arsenal, docks, &c.

Coming now to classes 2, 3, and 4, what force would be risked to destroy them? This would certainly be only of unarmoured cruisers; and taking again a force of one-tenth of their cruisers, we may put down 4 as the largest number they would risk losing in order to do serious damage to a place like Liverpool; for Bristol, 2, and for Dartmouth, 1.

The strength of four unarmoured cruisers may be taken as follows: —20 6-inch guns on each broadside. 400 men for landing party.

They would probably be accompanied by one transport with 1,000 men.

Two cruisers would be half this force without the transport, and one cruiser one-fourth, or 5 6-inch guns on the broadside, and 100 men.

It is not possible to give the details of the defence of each place in an essay like this, but only what it should be in general terms, and so the armaments will be divided into classes like the seaports. (Table C.)

The 1st-class defence would be a fortress with armament sufficient to meet 6 battle-ships; this would be 20 10-inch guns or their equivalent in the following table:—

1 8-inch gun	taken as	equal to	2	6-inch	guns.
1 9·2-inch	,,	,,	4	,,	,,
1 10-inch	,,	,,	6	,,	,,
1 12-inch	,,	,,	8	,,	,,
1 13·5 inch	,,	,,	10	,,	,,
1 16·25-inch	,,	,,	12	,,	,,

Also a simple system of submarine mines protected by a sufficient number of small quick-firing guns, electric search lights, &c.

The fortresses are the following, viz.:—Thames, Medway, Dover, Portsmouth, Portland, Plymouth, and Pembroke.

The 2nd-class defence would be—

18 6-inch guns, or their equivalent.
12 6-pr. quick-firers.
Submarine mines.

The following towns and rivers would be included in this class:—

Mersey, Clyde, Tyne, Wear, Tees, Humber, Queenstown, Belfast.

The 3rd-class defence would be:—

10 6-inch guns or their equivalent.
8 6-pr. quick-firers.
Submarine mine defence.

The following towns and rivers would be included in this class:—

Bristol, Cardiff, Aberdeen, Dundee, Forth, Harwich, Kingston.

The 4th-class defence would be:—

6 6-inch guns or their equivalents.
6 6-pr. quick-firers.
Submarine mine defence.

The following harbours are included in this class:—

Newhaven, Dartmouth, Falmouth, Waterford.

But the most important and most efficient form of defence is now to be considered separately, namely, the floating one, consisting of torpedo-boats and armed local steamers; it may be assumed as certain that no town or seaport will secure immunity from annoyance unless they have this floating defence, nor will they be able to keep their commerce from alarm when any strange cruiser is in the neighbourhood.

A certain number of torpedo-boats should be stationed at each port and manned locally by a volunteer crew, with two Regulars to each boat, a coxswain, and an artificer; the Naval Artillery Volunteers or, as a better name, the "Naval Volunteers," would be exactly the force to man these boats efficiently, as recently suggested by Mr. Arnold Forster; it seems incredible that any one should wish to disband this force of trained and zealous men who would turn their hand to anything; in war-time we shall be glad to get even the scum of the streets in our seaport towns, who will not only be untrained but who will not learn, and who will be a constant source of trouble.

For each fortress, 6 torpedo-boats should be localized; for towns and rivers of the 2nd class, 4 boats; for those of the 3rd class, 2; and for those of the 4th class, 1 boat; so that the total number required by the scheme would be 84 for the United Kingdom, and 91 abroad, or a total of 175.

The Admiralty have always refused to localize any of their sea-going ships, and rightly so, as it would be a dispersion and dislocation of their forces; but this does not apply to the smaller class of torpedo-boats, which are not really sea-going, and which have greater effect in a series of attacks in small groups than in one attack of a large mass together, the object being to wear the enemy out by constant vigilance.

Two or three of the fastest local steamers should also be fitted as guard boats against the enemy's torpedo-boats, armed with 3-pr. quick-firers, and manned locally by Naval Volunteers.

Practically speaking, therefore, these local vessels and torpedo-boats would form a second or inner line of defence against all raids that might elude the vigilance of the Royal Navy, and no one would care to affirm that there would be no such raids in these days of fast steamers; probably, however, they would not be attempted if it was known that these preparations had been made for their reception, and our coast would be secure from even the fear of an alarm at a minimum of cost.

The torpedo-boats and local steamers are classed as fixed defences,

because they would be strictly localized, and not be removed for other purposes, that is to say, they would be there when they were wanted, and not somewhere else.

The protection of commerce on the high seas must, of course, be the duty of the Royal Navy; but for the local defence of steamers loading or unloading, or of our men-of-war while coaling or under repair, these torpedo-boats, coast batteries, and mine-fields would be of the utmost value, especial attention being paid to the defence of the shipping against torpedo-boats by means of the electric light and quick-firing guns. Such is the great strain of modern naval warfare that our war-ships while at anchor in their own harbours should feel comparatively safe and their crews able to rest themselves, or else their vigilance and energies would flag when most necessary.

The fixed defences abroad will now be considered; are they required, and to what extent?

The primary reason why we maintain stations abroad is for coaling and repairing our ships-of-war; and, secondly, for coaling merchant steamers, and to give them places of refuge in the event of a stray cruiser being in the neighbourhood; for these reasons, therefore, fixed defences, including the floating ones already described, will be required, the amount depending on two considerations, viz.:—

1. The importance of the place.
2. The proximity of an enemy's base.

The importance of the place depends almost entirely on the trade routes in war-time: if there was a combination of France and Russia against us, would it be possible to maintain the Suez Canal route? It might be possible, but certainly not advisable for the following reasons:—

1. For one-half of the way in the Mediterranean it would pass at a short distance from hostile territory on either side, with numerous ports to shelter the enemy's cruisers.
2. To protect it would absorb an undue proportion of our own cruisers.
3. If anything happened to the Canal suddenly, which is a most likely thing, there would be a great block along the whole line.

Let it, therefore, be assumed that, at any rate at the commencement of war with two great Powers, the Suez Canal route would be restricted to troops, mails, and military stores, and the rest of the trade would be sent round the Cape, where it would be comparatively safe; this brings the coaling stations on that route into much greater importance than at times of peace.

It may be here pointed out that while our merchant steamers can coal without restraint at a neutral port, our cruisers cannot do so, and hence the importance of coaling stations near the trade route, if they are not actually on it.

Let us now trace all the trade routes, mentioning all our coaling stations on or near them, and also all the enemy's ports in a similar position, taking the hypothetical case of a combination of France and Russia as before us.

1. *Mail Route and Transports.*

Gibraltar, Malta, Famagousta, Perim, Aden, Kurachi, Bombay.

Enemy's ports: Toulon, Marseilles, Algiers, Boma, Tunis, Obock.

Here we have Gibraltar and Malta within easy striking distance of Toulon, where the whole strength of the French Navy is concentrated; accepting the principle that the enemy's ports in modern warfare will be watched by cruisers only, while the main body of the blockading fleet is at a base, Toulon presents a difficult case, unless Corsica is seized, as both Gibraltar and Malta are too far off; under these circumstances a portion of the enemy's battle-ships might escape, and make a raid on either of those places, accompanied by one or two transports; the limit might be taken as before, six battle-ships and two transports, but the time would be extended to seven days.

Gibraltar and Malta will therefore require a 1st-class or fortress defence, the former with a garrison of 3,000 men, the latter of 6,000.

Famagousta seems of little use to us as long as we hold Egypt, and it is far from an enemy's port, so that a defence of the 4th class will be sufficient, as it is only likely to be attacked by a stray cruiser. We should, however, be stronger in the Mediterranean without Cyprus.

Perim and Aden are near Obock, but this latter place would be speedily taken, so that the two former have to be considered with reference only to their importance, which would put Aden in the 2nd and Perim in the 4th class.

Neither Kurachi nor Bombay are within striking distance of any base but the former, as the base for our Army at Quetta should have a 3rd-class defence, and Bombay, from its great commercial importance, one of the 2nd class.

It is not for a moment proposed that our fleet should evacuate the Mediterranean; such a weak and pusillanimous policy would be a national disgrace and shame, and the prelude to the downfall of the Empire; we must, and we can maintain our naval supremacy there against any probable combination; all that is here suggested is that, at the commencement of war, our India and China trade should be diverted round the Cape, keeping the Suez Canal route for mails, troops, and stores, which would be sent overland if anything happened to the Canal; our fleet in the Mediterranean would then be free to defeat and destroy the enemy's fleets, and sweep the sea of all privateers under their modern guise of volunteer fleets; this being done, our trade can resume the Canal route in safety and comfort, and all panic will be avoided.

The difference of distance from Plymouth to Colombo, *viâ* the Cape and *viâ* Suez, is only 4,000 miles, or thirteen days for an ordinary, and ten days for a fast, steamer.

2. *China Trade Route.*

Having frankly given up the Suez Canal route, at all events at the commencement of war, this route will be as follows:—

St. Vincent, Ascension, St. Helena, Cape, Mauritius, Singapore, Labuan, Hong Kong.

Coaling stations, not on the main route: Gibraltar, Gambia, Sierra Leone.

Enemy's ports, near the main route: Goree, Gaboon, Réunion, Diego Suarez, Saigon.

Gibraltar would be the base for the protection of the route between Cape Finisterre and St. Vincent, with a temporary coaling station at Cape Blanco, on the north-west coast of Africa.

The Gambia is surrounded by the French territory of Senegal, where there is a force of 2,000 men; so that, unless an equal force is stationed at Bathurst, it must fall.

The great importance of Sierra Leone is hardly appreciated; it is the only coaling station for our cruisers protecting the trade route between St. Vincent and the Equator, which is threatened by the great fortress and arsenal of Goree, only 300 miles distant from the present peace route and 400 miles from the proposed war route, while Sierra Leone is distant 250 and 480 miles respectively from each; it is also within 500 miles of Goree, and is, therefore, exposed to a sudden raid by the troops stationed in Senegal.

It has a splendid harbour, and is easily defended, and should, therefore, have a defence of the 2nd class.

After passing the Equator, on as far as the Cape, there is little danger to the trade; Gaboon is the only port, but this is 1,200 miles from the war route, which can easily be protected from Ascension and St. Helena; these islands should each have a defence of the 4th class.

At the Cape we have Cape Town and Simon's Bay; these ports are not threatened by any of the enemy's, but from their importance, the first as a commercial centre, and the second as a naval arsenal, they should each have a system of defence of the 2nd class.

Between the Cape and Mauritius there is danger from Réunion, and after leaving Mauritius the route is threatened by Diego Suarez, on the north-east coast of Madagascar, both of which places would have to be taken as soon as possible after the outbreak of war.

Mauritius, being only 136 miles from Réunion and 600 miles from Diego Suarez, will require a 2nd-class defence.

After passing the Equator, the route can be efficiently protected from Diego Garcia, one of the Chagos Islands, as a base, with a defence of the 4th class, and there will be no danger until it converges on the Straits of Malacca, where it will have to be defended by Singapore and Penang; the latter place has been neglected hitherto, but is very important as a base for the defence of the western entrance of the Straits, and should have a defence of the 4th class; the enemy would probably use Sumatra as a base.

Singapore is a place of vast importance—it commands the highway to the East—and a dozen torpedo-boats stationed there could close the narrows at Carimon Island, only 9½ miles wide, against any of the enemy's cruisers, which would have consequently to go round by Sunda Strait, where they would have difficulties about coal; the smooth waters of the Straits of Malacca offer every advantage and

facility to torpedo-boats. Singapore is threatened from Saigon, where the combined China squadrons of the two supposed enemies would be concentrated, and which would give ours a considerable amount of trouble. Saigon would be a difficult place to attack, but fortunately for us there is the Island of Condore just outside, which would form a most convenient base for our fleet.

Singapore is less than 600 miles from Saigon, or forty-eight hours' steaming; it would be easy for a transport to slip out while the fleets were engaged, and land 1,000 men at the back of the island; if they could get in and destroy all the coal there, something like 100,000 tons, and sink ships so as to block up the New Harbour, they would do an incalculable amount of damage, and could give themselves up afterwards if they were seriously attacked. Singapore under these circumstances should have a 2nd-class defence.

The present peace trade route from Singapore to Hong Kong runs within 100 miles of the coast of Cochin China, where there are plenty of good harbours; the war-route would have to go *viâ* Labuan and the Palawan. Labuan in war-time would thus become of importance, but at present it has been utterly neglected, and has even been handed over to a chartered company; it possesses a fine harbour, inexhaustible mines of the best coals in the East, and has a fair climate; the Imperial Government should at once resume the control of the Island, and give it a defence of the 4th class.

We now come to Hong Kong, the terminus of our chain of ports in the far East, and the site of our naval arsenal for the China station; it is also only 900 miles from Saigon, and it is therefore liable to a sudden raid, both by cruizers to bombard the town, and troops landed from a trooper, in a similar way to Singapore, so Hong Kong must have a defence of the 2nd class. The Navy is sincerely glad that Port Hamilton has been given up; it was a bad harbour, and would have been a constant source of anxiety to the Admiral by taking away a portion of his force to defend it. In the event of a war with Russia our base of operations against Vladivostock would be one of the numerous bays on the Siberian or Corean coasts.

3. *Indian Trade Route.*

The Indian trade route in war will coincide with the China route as far as Mauritius; thence it bifurcates to Bombay, Colombo, Madras, Calcutta, Rangoon.

The route between Mauritius and Bombay will be liable to attack from Diego Suarez, especially at the outbreak of war, and would have to be protected from Mauritius and Seychelles as bases. The naval coaling stations near, but not on, this route are Seychelles and Trincomalee.

As stated above, Seychelles is one of the bases to protect the Bombay trade, and should therefore have a defence of the 4th class. Trincomalee is a naval yard as well as a coaling station, and should receive a 3rd-class defence.

The terminal stations have now to be considered.

Colombo is a very important mercantile port and coaling depôt, though it would lose some of its importance if the Suez Canal were closed, it should therefore have a 3rd-class defence.

Madras would best be protected by torpedo-boats, as shore batteries would protect neither the town nor the shipping in the roads.

Calcutta, on the other hand, is easily defended, and should have one of the 3rd class.

Rangoon will require no defence.

4. Australian Trade Route.

The Australian route in war-time would coincide with the China route as far as the Cape, and this fact emphasizes the importance of Sierra Leone as a naval base; the greatest, almost the only danger, to these vital arteries of trade, after it leaves the Channel, will be on that portion from Madeira to the Equator, and Sierra Leone is the only port anywhere near where our men-of-war can coal, except a temporary coaling station at Cape Blanco, as has been suggested; of course, if we had St. Vincent or Teneriffe, Sierra Leone would lose its importance.

The Australian route after leaving the Cape is as follows:—

King George's Sound, Adelaide, Melbourne, Sydney, Brisbane, Perth, Hobart, Wellington.

The route from the Cape to Melbourne may be considered perfectly safe; that from Melbourne to Brisbane and to Wellington is threatened from Numea, New Caledonia, Brisbane being 840 miles and Wellington 1,300 miles distant, while the Melbourne-Wellington route is 1,100 miles, and the Sydney-Wellington only 900 miles from it in round numbers; both these routes have to be protected from Sydney and Wellington as bases.

Taking these circumstances into consideration, the following defences will have to be provided for these places:—

King George's Sound, as an important coaling station, 4th-class defence.

Adelaide, torpedo-boats only.

Melbourne, 3rd-class defence, is very easily defended.

Sydney, being an important naval arsenal, and being near Numea, will require a 2nd-class defence.

Brisbane is up a river, so that a 4th-class defence will be quite sufficient.

Wellington is out of the way, but being the capital of New Zealand, with a fine harbour, should have a 3rd-class defence.

Hobart, as the capital of Tasmania, a 4th-class defence.

There still remain the important coaling ports of Newcastle, New South Wales, and Westport, New Zealand, each of which should be protected by a 4th-class defence.

Torres Strait would not be used as a main line, but there would be a considerable local trade to China and India; Thursday Island, as a coaling station, should have a 4th-class defence.

The homeward trade route would go *viâ* the Straits of Magellan, and is quite safe.

4. *North American Trade Route.*

Little need be said about this route in the supposed state of war. There is no enemy's base anywhere near, and the steamers are generally well able to look after themselves; the route to New Orleans would touch at Bermuda or Nassau, New Providence.

The only ports on this route are Halifax, Bermuda, Nassau.

Now that the Canadian Pacific Railway is an alternative route to the East, and as Halifax is the terminus at this end, and has also a small naval yard, it should have a defence of the 2nd class.

Quebec, guarding the St. Lawrence and the gate of Canada, one of the 2nd class.

Bermuda, as an important naval arsenal, should have also a 2nd-class defence.

Nassau does not require any defence.

5. *West Indian Trade Route.*

This route in war would take the same way as in peace, namely, to St. Thomas, one of the Virgin Islands, and thence to the other islands, Jamaica, Barbados, &c.

Port Royal, Jamaica, and Port Castries, St. Lucia, are the only naval ports near this route. Antigua, however, would have been a better place to have chosen than St. Lucia as a fortified coaling station for the following reasons:—

1. It is much nearer the trade route.
2. It is much healthier.
3. It possesses a land-locked harbour, which, though small, is quite large enough for any ship that may want to use it, and which is easily defended.

As it is doubtful whether white troops could garrison St. Lucia for any time, I shall substitute Antigua for it.

In dealing with the West Indies, we must look forward to what will happen in ten years' time, when the Nicaragua Canal will be opened; their importance then will be vastly increased. The trade route will then go through the Mona Passage, and Jamaica will be the coaling station before ships pass through the canal.

The enemy's ports near this trade route are Guadaloupe and Martinique. Considering the proximity of these two islands, with their large garrisons and the probability of a raid on Antigua by a military force in a troop-ship, Antigua should have a 3rd-class defence.

Port Royal is easily defended, and considering its future importance, although it is so far from Martinique, over 1,500 miles, that it is not likely to be raided like Antigua, it should have a 2nd-class defence.

6. *South American Trade Route.*

This route would be the same in war as in peace, namely, St. Vincent, Rio de Janeiro, River Plate, Straits of Magellan, and up the west coast of South and North America.

The only foreign enemy's port near this route is Goree, and it will be a safe one after passing the Equator, except perhaps a stray cruiser in the Straits of Magellan.

We have no ports for coaling our men-of-war on this route till it reaches Vancouver Island; the Falkland Islands, however, are near it before it enters the Straits, and hence the importance of these islands.

It may here be asked, How could an enemy's cruiser remain in the Straits of Magellan with their nearest base at Goree?

The reply is, that in uncivilized countries like Tierra del Fuego, and also the north side of the Straits with its numerous harbours, meeting places between the cruisers and colliers will be arranged beforehand where there is no local authority to stop them; of course this would be found out in time by our cruisers, but it would be very effective against our commerce on the outbreak of war, which, indeed, is the most dangerous time of all.

The same thing would happen also in the East Indies, where there are many places in which the local authorities could not enforce International Law, even if they had the will, for this essay is founded on the law that coal is contraband of war, and that neutrals will enforce this law, the only exception being that a belligerent cruiser may take in enough coal to reach the nearest port once, and once only, during the war; if this law is not enforced, then any coaling stations are useless, as our cruisers could coal much more safely in neutral ports.

The Falkland Islands are 350 miles from the trade route, and 400 miles from the entrance of the Straits of Magellan. The route from the Straits of Magellan as far as Vancouver Island runs along neutral territory all the way, and is quite safe.

7. *Panama-Australian Trade Route.*

Here we have a long and exposed ocean passage, which will become of vast importance when the Nicaragua Canal is opened.

Our ports on this route are Fiji and Sydney. Fiji, being about 6,000 miles from Panama, is too far for an ordinary steamer to go without coaling. Fortunately we have taken possession of the Caroline Islands, in lat. 12° S. and long. 150° W., all the others in the neighbourhood belonging to the French. The Caroline Islands are about 4,000 miles from Panama or the entrance of the Nicaragua Canal, and 2,000 from Fiji, which are convenient distances; so it is to be hoped that there is a good harbour, as it has been observed all the surrounding islands are in the hands of France. Tahiti, the headquarters of the French Pacific squadron, is 460 miles from the Caroline Islands, and the Marquesas are directly on the line of the main route.

Between Fiji and Sydney, 1,780 miles, the route would be exposed on the flank to New Caledonia, which is only 180 miles distant from it.

Taking into consideration the vast importance of the Caroline and Fiji Islands when the Nicaragua Canal is opened, and the very exposed condition of the great trade routes through it to Australia, since every island in the Pacific would be a convenient place for an enemy's cruiser to coal from a collier sent out there, Fiji should have a 2nd-class and the Caroline Islands a 3rd-class defence.

8. *Vancouver-Australia Trade Route.*

The ports on this route are Vancouver Town, Esquimalt, Honolulu, and Fiji, and it may be considered a safe one as far as Fiji, there being no port of the enemy anywhere near it.

Vancouver Town, as the terminus of the Pacific Railway, and Esquimalt, as a naval arsenal, are both exposed to a raid from Vladivostock or rather Petropaulovski, distant 3,000 miles, or a week's steaming for one of the new volunteer fleet.

Esquimalt should therefore have a 2nd-class, and Vancouver Town a 3rd-class defence; while the coal mines at Nanaimo require a 4th-class defence.

9. *Vancouver-Yokohama Trade Route.*

We now come to the last important main trade route, that across the Pacific from Vancouver to Yokohama. This starts from a well-defended port and ends at a neutral one, and is not threatened by any port of the enemy on its flank, so that it can well look after itself; any cruisers protecting the Japan end would obtain their coal at the port or harbour seized by our China Fleet on the coast of Russian Tartary or Corea. The local routes between Hong Kong and Shanghai and Yokohama require little notice; they have numerous neutral ports under their lee, and are comparatively safe.

To conclude the first part of our subject, namely, "To what extent, if any, should our naval force be supplemented by fixed defences at home and abroad," it has been shown that as long as we have command of the sea, no enemy would risk the loss of a large portion of his fleet by attacking any of our ports, that they would possibly risk a small force of about one-tenth of their battle-ships with two transports of troops to destroy one of our great arsenals, if they saw the chance, but that probably our other ports would only be exposed to raids by from one to four cruisers, and perhaps one transport, according to their wealth and importance and their nearness to the enemy's base of operations.

The shipping in our ports will, however, always be subject to attack from the enemy's torpedo-boats if they are not adequately protected.

It may here be remarked that no supposed International Law

would for a moment prevent an enemy from requisitioning or bombarding what is called an "undefended port" if he found it pay him to do so; this principle has been distinctly taken up by the school of the late Admiral Aube, and has never been denied; the only thing to be said is that two can play at that game.

All our fixed defences have therefore been divided into four classes, so as to be able to treat them in a general manner, and all our principal commercial ports and harbours have been placed in one of these classes, it being assumed that they might have to repel the determined attack of from one to four cruisers, and also assumed that a certain number of guns in batteries on shore are more powerful than an equal number afloat. Our submarine telegraph cables must most certainly be considered in conjunction with our fixed defences; their importance is incalculable, especially at the commencement of war; the want of them, and, still more, false news sent by them, for instance, from Saigon to Hong Kong or Singapore, would cause immense damage, far exceeding the cost of the cables.

The following sea cables are strongly urged as necessary, viz.:—

1. Sierra Leone, Ascension, St. Helena.
2. Singapore, Labuan, Manila; the latter place is already connected to Hong Kong.
3. Auckland, Fiji Islands.
4. Zanzibar, Seychelles, Mauritius.
5. Monte Video, Falkland Islands.

Also the following land lines, viz.:—

1. Bhamo, Yunan.
2. Mergui, Malacca, Singapore.

These two lines would make Hong Kong and Singapore independent of the cables.

The protection of our commerce on the outbreak of war can only be secured by compelling it to follow certain fixed routes; these should be laid down beforehand and called A, B, C, &c., and all shipowners and masters should be acquainted with these routes.

On the outbreak of war, all steamers would proceed by the route telegraphed out confidentially from the Admiralty, and the route changed by telegraph whenever necessary; for instance, one route might pass 50 miles to the eastward of St. Helena, another, 100 miles, and so on; by this means our cruisers would know where to find our commerce, but the enemy would not.

All sailing ships would be stopped and laid up at the same time.

If these precautions are adopted, our commerce ought not to suffer very severely, and there ought to be no panic.

In an essay by the author, sent to compete for the medal of the Royal United Service Institution some years ago, it was strongly urged that the Government should pay all extra war insurance premiums; this would prevent our trade being transferred to another flag, this meaning the total loss of our carrying trade and absolute ruin to the country.

If our maritime supremacy is assured, and if the above scheme of fixed defences to supplement it is carried out, our loss of commerce

should not exceed 10 per cent. per annum, most of it falling on the first year; since a modern merchant steamer is far better able to take care of itself than the old sailing vessel. An enemy's cruiser should be made out at a distance of 12 miles, and say she has the advantage of $1\frac{1}{2}$ knots extra speed, she would take eight hours to come up with the merchant steamer, or, in other words, any vessel sighting an enemy's cruiser after noon, has a very good chance of escape at night, even if none of our own cruisers should turn up.

There is one point of International Law that ought to be decided at once—Is a defenceless merchant steamer liable to be torpedoed and sent to the bottom while trying to escape, or is she not? This question is of great interest to our civil population.

The proposed scheme of fixed defences has been founded on the following principles:—

1. That our naval supremacy is unquestioned.
2. That our fleets are off the enemy's ports and guarding the trade routes.
3. That, however well the enemy is watched, a few cruisers may escape and make a sudden raid.
4. That the action of these cruisers is strictly limited by their means of obtaining coal.
5. That, if there are no fixed defences, a portion of our fleet will have to be detached to defend the ports locally.

Having considered to what extent our naval force should be supplemented by fixed defences at home and abroad, we now come to the second part of our subject, viz., "To whom should they be confided?"

Here we are encountered by two totally different schools of thought and opinion, the first holding that the fixed defences should be entrusted to the Navy, the second that they should remain in charge of the Army.

The arguments for the former may be briefly stated as follows:—

1. Most foreign Powers have placed their ports under naval control.
2. Most of our ports abroad being simply coaling stations and bases for the Navy, they should be, therefore, under the control of the naval Commander-in-Chief of the station.
3. To avoid dual control and different objectives of defence.

It is generally acknowledged that these principles only apply to certain ports (see Table D), and exclude all the ports at home, in India, in Canada, and in Australia, leaving only those shown in the list as Imperial Ports to be dealt with.

Others, again, say that the theory is correct, and that, if we began again, it would be the right thing to do, but that it now would be quite a revolution to effect a change.

With reference to the first argument, our necessities are totally different from all foreign Powers.

Granted our naval supremacy, our naval policy is offensive, and the station of our fleets is off the coasts of the enemy, remaining only in our own ports to coal, to repair, or to await an opportunity to

pursue the enemy, and on no account should they be tied up there; our adversary's navy, on the other hand, would act on the defensive, and would remain in their own ports for indefinite periods. Such being the case, it is plainly manifest that a system of defence which would be suitable to a weaker naval Power would not necessarily be so to the stronger.

Where the fleet have no intention of leaving the shelter of the port, it may be desirable to place the whole control under naval authority.

With reference to the second argument, our ports abroad are commercial centres and coaling places for our mercantile marine, as well as for the Navy, the interest of the Navy being solely confined to the safety of the dockyards and coal stores, whereas a military base is part and parcel of the military operations. If the different ports were under the control of the naval Commander-in-Chief, it would tie his hands considerably, and add tremendously to his responsibilities, without any commensurate advantage; instead of devoting all his energies to attacking the enemy's fleets wherever found, he would constantly have to keep his attention on the local defences of the different ports in his charge.

With reference to the third argument, dual control of the land and sea forces would certainly be abolished by having the ports under naval Officers, who would be under the naval Commander-in-Chief; the Officer in charge of the defence of the port would probably, however, have a different objective: his first idea being local defence only; that of the Admiral, the pursuit of the enemy and defence of commerce on the high seas.

If the Imperial ports are confided to the Navy, they would have to be manned either by marines or seamen.

Now the Marines are perfectly competent to undertake any duty they are called on to perform, and would form most efficient garrisons; but in doing this would they not cease to be marines, and become merely a land force under Admiralty control, like the French marines?

At present the force is 14,000 strong, of whom 7,000 are on board ship, or, excluding mere harbour ships, there are about 5,000 men in sea-going ships, or over one-third of the whole force; so that every man of twelve years' service will have been four years in a sea-going ship; and it is just this period afloat which gives the corps its peculiar and valuable qualities.

The garrisons required for the Imperial ports only, according to Table D, is a total of 22,000 men, which is a very moderate estimate; one-half more will at least be required for reliefs, or 11,000 men: total 33,000; adding 14,000, the present number, we get a grand total of 47,000 men. Supposing every man took his turn, he would only have a little more than one year's service in a sea-going ship, which is manifestly not enough, and the tendency would be for the corps to become a land force only.

Again, a certain proportion of many garrisons should be non-European, who could stand the climate better than Europeans, and who, of course, could never be marines.

Trincomalee, Colombo, Mauritius, Penang, Singapore, Hong Kong, and Fiji should have half their garrisons composed of Sikhs, Afghans, &c., and Sierra Leone, Antigua, and Jamaica half of Africans; the West Indian troops should be withdrawn from Africa and replaced by Houssas or Zulus. It seems strange that we have never taken advantage of the splendid fighting qualities of the great Zulu nation.

In order not to break up regiments unnecessarily, and to take advantage of the adaptability of the Marine Corps to provide small detachments, some of the smaller stations might be manned by marines; for instance, Ascension, St. Helena, Seychelles, Chagos Islands, Labuan, Falklands, and Caroline Islands, would want 1,400 men altogether; and, adding one-half for reliefs, we have a total force of about 2,000 men, which, if added to the Marine Corps, would not alter its constitution.

These islands being garrisoned by marines, would naturally fall under naval control, since they are not of sufficient importance to tie the hands of the Admiral, or to add materially to his responsibilities.

The objections already stated against the use of marines as garrisons for our Imperial coaling stations hold with much greater force against the employment of naval Officers and seamen on such duty, and there are also others in addition.

The present number of bluejackets or *bonâ fide* seamen is about 20,000, and, adding the 33,000 required for the coaling stations, would make a total of 53,000; this would give the seamen only about $\frac{1}{4}$ of their service in a sea-going ship, instead of $\frac{3}{4}$ as at present.

It has been shown that many of our important coaling stations are always open to a sudden land attack owing to the proximity of an enemy's base holding large forces; it is manifest that such operations on land should be entrusted to military Officers, and not to naval Officers.

The tendency of the present day in all modern sciences is towards dividing them into specialities, from the impossibility of any one man making himself a thorough master of the whole of them; how, then, can it be proposed that a naval Officer should undertake the study of military science, itself the work of a lifetime, in addition to making himself proficient in all his many other duties?

Is the Admiral in command of the Fleet to work out all the plans for the defence against a land attack on the different places in his charge, and is he to take personal command of the operations, or is he to leave these matters in the hands of the Officer Commanding? If he does the latter, he ought to have nothing to do with the defence of the place at all, and if he does the former, he will probably be neglecting his purely naval duties. No, he should not have to do either one or the other, but have his mind free to devote itself to naval problems; as the motto at the head of this paper says, "Let the cobbler stick to his last," and every man attend to his own business; naval Officers and seamen should not be required to take part in land operations against a modern civilized army until the Fleet is driven off the sea, or has won such a complete victory that

the services of the seamen are no longer required afloat. Seamen can take part with great effect in land operations against undisciplined or savage nations; but on those occasions their services are not required on board, and no great military training is necessary for that class of warfare.

The conclusion come to, therefore, is this, viz.: That our fixed defences at home and abroad should be confided to the military, with the exception of some small minor stations which should be manned by marines, to avoid the evil of breaking up a whole regiment into small detachments.

There is one part, however, of the fixed defences in which the principle expressed in our motto is broken with a vengeance, and in a most extraordinary manner, and that is the work of planning, laying down, and manipulating the different systems of submarine mines.

If any subject was a purely naval subject in the world, one would think submarine mining was one, since even balloons are now included in the naval répertoire.

1. The whole paraphernalia of cables, mines, buoys, boats, &c., are naval.

2. The sphere of action of the mines is in the water.

3. They are laid down and taken up by boatmen in boats.

4. Perfect familiarity with tides, winds, and currents is necessary.

5. Knowledge is required of the construction of ships and of their movements in narrow waters.

6. The object of submarine mines is to destroy ships of the enemy, but not those of a friend; the operator should therefore know one ship from another.

7. Close acquaintance with the art of navigation in pilotage waters is absolutely indispensable, so as not to obstruct the free movement of trade, especially in our case, where our sea commerce is our very life-blood, and we cannot even afford to delay or annoy it, much less close any port altogether, as some foreign Powers might do without harm to themselves.

Taking all these things into consideration, would it be believed by the public in general that this important and exclusively naval work is in the hands of soldiers and landsmen?

No wonder that in a recent report it was stated that if the proposed systems of submarine mines were laid down at our ports, the free navigation of them would be seriously impeded.

It is not implied that the Royal Engineers do not do the work well according to their lights, but it is affirmed that the Navy would do it better, in the same way as operations on land would be better performed by soldiers, although sailors would do their best.

It has been stated as an argument that the system of submarine mines ought to be laid down and controlled by those who plan and work the forts, but this is simply putting the cart before the horse, for what is the object of our harbours both at home and abroad? Is it not that our ships may go in and come out freely? It is

certainly not that they should be blocked altogether, on the chance of an enemy's cruiser coming in and getting blown up; sooner than this, no mines should be laid down at all. Let the system of mines be planned and laid down by the Navy with due regard to navigation, and then the Engineers can build the forts necessary to defend them; these, in fact, will be simply small batteries of quick-firing guns, as the mine-field would only be attacked by boats or small vessels.

Therefore it is most strongly urged that the whole of our submarine mining defence, including the quick-firing guns and electric search lights necessary for their protection, should be confided to the Navy, and to the Navy alone, both at home and abroad, and thus abolish the anomaly of a purely naval weapon of defence being worked by landsmen.

What, then, is recommended so as to combine our sea and land forces to the greatest effect? First, that the money spent on our fixed defences should bear a proper proportion to that spent on our naval force; and, secondly, that there should be unity of control at each of these fixed defences.

The only way to secure that the total amount of money for the defence of the Empire should be properly expended is to place the whole of our land and sea forces under one powerful Minister of War, who, if he is not Prime Minister, should be next him in political influence.

This War Minister should be advised and assisted by two high Officers, one a General in command of the Army, and the other an Admiral in command of the Navy; these Officers to be members of the Privy Council.

A General Staff for the Army, and one for the Navy, should be created to advise these Officers in command on all subjects relating to war, the members of these two Staffs to meet together once a week for mutual consultation.

The Minister of War would not concern himself with the details of his department, which would be left to his two assistants, but only with the general strategy required for the defence of the Empire, and the strength and disposition of its forces; he would keep in his own hands the movements of fleets and armies, and also the appointments of all Flag and General Officers.

By our Parliamentary system of government, it is necessary that the head of a great spending department should be a politician, but, as a rule, he knows nothing of the details of either the Army or Navy, and he should not be required to waste his time in trying to learn them, but they should be left to his professional advisers; the general strategy of war can, however, be firmly grasped by civilians of genius such as the elder Pitt, and what grander sphere can there be for an ambitious Minister than to aspire to the control of all the forces of this vast Empire, and rival the fame of that mighty statesman?

To obtain the second object, viz., unity of control at the fixed defences, a naval Officer should be attached to the Staff of the General Officer Commanding at every port both at home and abroad.

At home, this Officer in the fortresses would be of the rank of

Captain, R.N.; in all other parts of the United Kingdom he would be the Inspecting Officer of Coastguard.

Abroad, there would be Captains, R.N., for the fortresses, Commanders for defences of the 2nd class, and Lieutenants for those of the 3rd and 4th classes.

This naval Officer to have entire command and control and charge of all the purely maritime portions of the defences, manned and worked by seamen:—

1. Torpedo-boats.
2. Armed local steamers.
3. Brennan and Whitehead torpedoes.
4. Submarine mines.
5. Quick-firing 6-pr. batteries to defend ditto.
6. Electric search lights to defend ditto.
7. Naval Reserve.
8. Naval Volunteers.

During the time he is on the General's Staff, he is to be under the command of that Officer.

The general conclusions come to on the subject of this essay are as follows:—

1. That to the Navy should be entrusted the duty of sweeping the high seas and of keeping them clear of the enemy's cruisers.

2. That, after our maritime supremacy has been assured by building a sufficient number of ships, our naval force should be supplanted by certain fixed defences, raised to meet a definite purpose at our different ports at home and abroad; this purpose being to resist a raid or attack by one or more cruisers for a few days, and to offer a safe refuge for our war-ships and mercantile marine while coaling, loading or unloading, or under repair.

3. That these fixed defences are of little use, since they could not keep the entrance of the port clear, or prevent the attack of torpedo-boats, without a floating defence consisting of torpedo-boats and armed local steamers acting as guard-boats.

4. That these fixed defences should be under military control, but that all the purely naval or maritime portion of the defences should be manned and worked by seamen under a naval Officer attached to the Staff of the General Officer in command.

5. To avoid, however, breaking up regiments into small detachments unnecessarily, certain small coaling stations abroad should be manned by marines and seamen and placed under naval control.

6. That the only way that our naval and military forces can be kept in their proper proportion, and used with the greatest effect, is to place them both under one Minister.

TABLE A.

Nation.	Armoured.				Unarmoured.				Gun-vessels.
	Battle-ships.	Coast service.	Cruisers.	Total.	Cruisers, 1st class.	Cruisers, 2nd class.	Cruisers, 3rd class.	Total.	
Built 1891.									
England	32	15	20	67	0	24	44	68	16
France.....	13	5	5	23	5	2	11	18	8
Russia.....	5	9	8	22	2	3	15	20	3
Building 1891.									
England	10	0	0	10	11	26	0	37	17
France.....	8	4	5	17	0	6	4	10	4
Russia.....	7	0	2	9	0	0	0	0	5
Total, 1894.									
England	42	15	20	77	11	50	44	105	33
France.....	21	9	10	40	5	8	15	28	12
Russia.....	12	9	10	31	2	3	15	20	8
France and Russia } ..	33	18	20	71	7	11	30	48	20

Notes on Table A.

1. All wooden or composite ships and all armour-plated ships under 2,000 tons are omitted.
2. Third class battle-ships are classed as armoured cruisers.
3. H.M.S. "Sultan" and the Russian Volunteer Fleet, built and building, are not included.
4. "Rupert," "Hotspur," "Belleisle," and "Orion" are classed as coast service.
5. Fast ships of the "Rattlesnake" type are classed as gun-vessels; all other small craft are omitted.

TABLE B (1).—*At Home.*

Place.	Class.	Torpedo-boats.	Garrison.	Total.
Thames	1	6	3,000	
Medway	1	6	3,000	
Dover	1	6	3,000	
Portsmouth	1	6	6,000	
Portland	1	6	3,000	
Plymouth	1	6	6,000	
Pembroke	1	6	3,000	27,000
Mersey	2	3	1,500	
Clyde	2	3	1,500	
Tyne	2	3	1,500	
Wear	2	3	1,500	
Tees	2	3	1,500	
Humber	2	3	1,500	
Belfast	2	3	1,500	
Queenstown	2	3	1,500	12,000
Total	..	66	..	39,000

TABLE B (2).—*At Home.*

Place.	Class.	Torpedo-boats.	Garrison.	Total.
Bristol	3	2	400	
Cardiff	3	2	400	
Aberdeen	3	2	400	
Dundee	3	2	400	
Forth	3	2	400	
Harwich	3	2	400	
Kingstown	3	2	400	2,800
Newhaven	4	1	200	
Dartmouth	4	1	200	
Falmouth	4	1	200	
Waterford	4	1	200	800
		18		3,600
		66		39,000
Total at home	..	84	..	42,600

TABLE C.—*Class of Defences.*

First Class or Fortress.

Twenty 10-inch guns or their equivalent.
Eighteen 6-pounder quick firers.
Four electric search-lights.
Six torpedo-boats.
Garrison, 3,000 men.

Second Class.

Eighteen 6-inch guns or their equivalent.
Twelve 6-pounder quick firers.
Three electric search-lights.
Three torpedo-boats.
Garrison, 1,500 men.

Third Class.

Ten 6-inch guns or their equivalent.
Eight 6-pounder quick firers.
Two electric search-lights.
Two torpedo-boats.
Garrison, 400 men.

Fourth Class.

Six 6-inch guns or their equivalent.
Six 6-pounder quick firers.
Two electric search-lights.
One torpedo-boat.
Garrison, 200 men.

Note.—1. These classes of defence are calculated for ports or harbours with only one entrance; for all those with two entrances, double the armament will be required, and an addition to the garrison of one-third of its strength.

2. The garrisons do not include the seamen required to man the torpedo-boats, work the submarine mines, electric lights, &c.

TABLE D (1).—*Abroad.*

Imperial Garrisons.

Place.	Class.	Torpedo-boats.	Garrison.	Total.
Malta	1	6	6,000	
Gibraltar	1	6	3,000	
Sierra Leone	2	3	1,500	
Cape Town	2	3	1,500	
Simon's Bay	2	3	1,500	
Mauritius	2	3	1,500	
Colombo	3	2	400	
Trincomalee	3	2	400	
Penang	4	1	200	
Singapore	2	3	1,500	
Hong Kong	2	3	1,500	
Bermuda	2	3	1,500	
Antigua	3	2	400	
Jamaica	2	3	1,500	22,400

TABLE D (2).—*Abroad.*

Place.	Class.	Torpedo-boats.	Garrison.	Total.
Marine Garrisons.				
Ascension	4	1	200	
St. Helena	4	1	200	
Seychelles	4	1	200	
Chagos	4	1	200	
Labuan	4	1	200	
Falklands	4	1	200	
Carolines	3	2	400	1,600
Indian Garrisons.				
Aden	2	3	1,500	
Perim	4	1	200	
Kurachi	3	2	400	
Bombay	2	3	1,500	
Madras	2	3	1,500	
Calcutta	3	2	400	5,500

TABLE D (3).—*Abroad.*

Place.	Class.	Torpedo-boats.	Garrison.	Total.
Australian Garrisons.				
St. George's Sound	4	1	200	
Adelaide	3	2	400	
Melbourne	3	2	400	
Sydney	2	3	1,500	
Newcastle	4	1	200	
Brisbane	4	1	200	
Thursday Island	4	1	200	
Wellington	3	2	400	
Westport	4	1	200	3,700
Canadian Garrisons.				
Halifax	2	3	1,500	
Quebec	2	3	1,500	
Vancouver Town	3	2	400	
Esquimalt	2	3	1,500	
Nanaimo	4	1	200	5,100
Total abroad	..	91	..	38,300
Grand total	..	175	..	80,900

NAVAL ESSAY.

(HONOURABLY MENTIONED.)

MARITIME SUPREMACY BEING ESSENTIAL FOR THE GENERAL PROTECTION OF THE BRITISH EMPIRE AND ITS COMMERCE, TO WHAT EXTENT, IF ANY, SHOULD OUR NAVAL FORCE BE SUPPLEMENTED BY FIXED DEFENCES AT HOME AND ABROAD, AND TO WHOM SHOULD THEY BE CONFIDED?

By Lieutenant EDMUND HYDE SMITH, R.N.

"England by her Navy must stand or fall."

Introduction.

WITHIN the last few years no question has been so warmly discussed as the advisability of supplementing the defence of the British Empire, left in days of old to the Fleet and a field army, with passive or fixed defences, requiring, in most cases, permanent garrisons.

Two extreme views have been taken. In discussion, both sides have occasionally overstated their case. Arguments have been used, on the one hand, which have for their premiss the total defeat of our fleet, or fleets, without their having inflicted enough damage on the enemy to deter him from at once undertaking further operations without refitting.

The other view assumes that, on the outbreak of war, the Fleet have, or should have, a sufficient superiority to ensure the command of the sea, and argues that, as every individual fleet, squadron, or ship of the enemy will be well looked after, there will remain no necessity for fixed defences.

I believe that the solution of the question is to be found in a happy mean, in which the Fleet and fortifications form part of one harmonious scheme of defence.

No proper conclusions as to the necessity for, or amount of, fixed defences for our maritime ports and coasts can possibly be arrived at without considering to what attack they may be subjected. To arrive at this conclusion it is necessary to carefully consider the relations between the operations of the Fleet and territorial attacks by the enemy. In doing so, it must be remembered that maritime

supremacy is assumed, and that by maritime supremacy is meant, in our case, an ability to afford a good share of protection to our trade, and a sufficient fleet to meet the enemy with equal or superior force, as much for the protection of trade as for the prevention of territorial attacks under cover of our ships. I shall accordingly divide my essay into four parts, viz.:—

i. The amount of protection afforded to ports and seaboard by the operations of our Fleet.

ii. Cases in which such defence would become inoperative, and the nature of attack to which our territories could be subjected.

iii. Nature of protection proposed to be afforded to different ports by passive defences.

iv. Control and personnel of coast defence.

PART I.—*Amount of Protection afforded to Ports and Seaboard by the Operations of the Fleet.*

Irrespective of the defence of territory, let us first enquire what would be the duties of the Fleet in the event of war with a great maritime Power or Powers.

Duties of the Fleet.—These I should enumerate as follows:—

i. Masking the enemy's fleets by superior force. This necessitates having large numbers of look-out ships, in addition to a superior fighting force.

ii. Keeping the fleets' lines of communication open with the base or bases. (Necessary to ensure the supply of coal, provisions, and munitions of war being not interfered with by escaped raiders.) For this work, fast cruisers would be necessary.

iii. Patrolling the trade routes:—

(*a.*) On the ocean highways and where routes converge on the high seas.

(*b.*) In the vicinity of the commercial ports, to keep them open.

Of these duties—

(*a.*) Must be performed by fast cruisers;

(*b.*) Can be performed by vessels of less speed and radius of action than (*a*), provided that they are sufficiently well armed and protected.

iv. If it is conceded that the Fleet's duties do embrace the protection of territory, including the defence of the United Kingdom against invasion, then a reserve or flanking fleet becomes necessary. Such fleet may be much smaller than the enemy's main fleet, masked by ours. Its duties would be to threaten and, if necessary, engage the enemy, should our masking fleet suffer a reverse. They would, however, prefer to avoid an engagement until reinforcements from the defeated fleet placed them in a position of superiority.

Frequently these duties overlap one another. Sometimes a ship might be efficiently performing several of them. Thus, a vessel running between a fleet off Brest and Plymouth would be patrolling

the trade route from Ushant to Plymouth, keeping open the communications of the fleet, and, by making the Lizard, assisting to keep Falmouth open. She would also, whilst in England, be ready to reinforce the Reserve Fleet at short notice.

Sometimes, on the other hand, a ship would have to be confined to one particular service, and she could not be depended on for other purposes.

Let us now consider how far these operations will, if efficiently performed, affect the question of fixed defence.

And first let us consider (i), viz., the masking or holding in check the enemy's fleet by superior force.

With an enemy's fleet free, the first operation of our own should be to gain touch of him. This is as much a principle of naval as of military warfare. Fortifications could not, in this case, free fleets for offensive operations, as is sometimes maintained. If the enemy's fleet attempted to attack our coast, the duty of our fleet would clearly be to attack him. It is a strange misconception of the operations of war which supposes an enemy's ships steaming round our coasts, bombarding our towns, whilst our own ships are performing somewhat similar operations on theirs.

The place for our ships is where those of the enemy are. If we, being in a proper position of supremacy, make proper disposition of our force, we should have touch of the enemy's ships on the first outbreak of war. If, *then*, no ships evade ours, his only means of undertaking territorial attack lie in inflicting a crushing defeat on our Fleet, and by having afterwards a sufficient force in a fit condition to accomplish his particular purpose. As our Fleet is, by hypothesis, superior, all human probabilities are against his success.

Even had he the good fortune to defeat us, the condition of his own fleet would hardly be one in which to conduct any further operations without refitting. Our Fleet would have at least equal facilities for doing the same.

This argument expressly leaves out of consideration the operations of a Reserve Fleet, stationed always in the Channel. If such a fleet existed, an enemy would have to deal with them before he could go further. They would be reinforced at once by such of our ships of the main fleet as were uninjured in the defeat, not to mention the cruisers, coast-defence ships, and torpedo-boats, which would, on such an emergency, leave their special stations round the coast of the United Kingdom.

Let us imagine our fleets have sustained a crushing defeat, and that they are masked in one of our arsenals by a superior force of the enemy. We will suppose that he then has a force free sufficient for further operations. Granted that a small defence of the port would prevent an enemy from entering the harbour, he would, however, be in a position, if he chose, to undertake a siege by land and sea. As he would have, in that case, our land forces on his rear, he would hardly waste time over such an attempt, which, if it succeeded, would not pay him so well as an attempt to invade the country, combined with the interruption of our supply of food and raw materials.

It may be therefore, I think, assumed that in such a case an enemy would, if his superiority was well established, attempt to invade the country and interrupt our trade; if he was afraid of having his retreat by sea cut off he would attempt the latter only, and this fortifications would be powerless to prevent. I therefore think that to fortify forts against a *siege* is a distinct waste of money and men.

Against an enemy being in this position, I believe a reserve or flanking to be the best safeguard. Whilst being better than any possible fortifications, such a fleet has the additional advantage of protecting trade and communications, which functions cannot be claimed for fixed defences. It is sometimes argued that if inferior in force to the enemy it would be no defence. An inferior force is, however, a defence until defeated and held in check by the enemy, and in our case this fleet does not stand alone; by our hypothesis a fleet originally superior to the enemy has been defeated, and is refitting. The Reserve Fleet is therefore an inferior force expecting at any time reinforcements which will make it greatly superior to the enemy. The latter, uncertain where the reinforced fleet might be expected to attack him in superior force, would not risk being caught in any territorial enterprise, the most dangerous position in which to be caught. Nelson and the French fleet at Aboukir afford a sufficient instance; Napoleon's genius could not extricate his army with supplies from, and retreat to, the sea cut off. An enemy's best plan would obviously be to catch the Reserve Fleet with his superior force and utterly crush it. This the Reserve Fleet could easily avoid, even to the extent of retiring into the port in which the ships refitting were lying. A very moderate defence (considered subsequently) would be sufficient to prevent the enemy from entering. Our Commander would take care not to allow himself to be blockaded within, except by the bulk of the enemy's force, without which the enemy (on the hypothesis of his original comparative strength) could not maintain his position. And if he there maintained his position, his *war*-ships would not be free to undertake or cover further attack. If he left, the Reserve Fleet would also be free, and in the position previously dealt with.

This, I think, covers the most pessimistic view which it is possible to take. It is highly improbable that a superior fleet would, in the first instance, suffer such a grievous defeat as to render such events possible. Under ordinary circumstances, should our main fleet meet with reverses, the enemy himself would be considerably damaged. The Reserve Fleet would, by reinforcing, be a complete answer to any probable attack.

It may be conceded that London is particularly open, being close to the south and east coasts, where there are many places suitable for the disembarkation of troops.

Transports must, however, have war-ships to cover them. A few torpedo-boats, covered by two or three fast cruisers, would otherwise settle their fate.

The possibility of an enemy being able to do this has been already discussed.

As a substitute for the Reserve Fleet proposed to prevent this, there are those who advocate a very complete system of fixed defences for, at any rate, our southern and eastern coasts.

They say that *all* estuaries, creeks, rivers, ports, or places suitable for a landing should have fixed defences to assist the troops in preventing it. And the necessity is claimed, whether the port is or is not of commercial or naval importance.

All these positions would have to be fortified against, and fit to engage, an enemy's war-ships. Infantry and field artillery could not remain in permanent field-works in the face of such ships' fire.

Thus, wherever such positions were made for a resistance on the shore, heavy guns would have to be mounted sufficient to resist an attack made by a force which it would be unsafe to state at less than four ironclads.

For miles along the south coast alone, there are open beaches suitable for the disembarkation of troops, on a broad front, on almost any day in summer. To be logical all these must be fortified. It is no use fortifying this place or that place as against invasion. No sane enemy would metaphorically knock his head against a stone wall. If he could find one, he would disembark in an unfortified position. The claim practically amounts to a cordon of forts on a large portion of the south and east coasts. Our coast line will then be our frontier. We should on this plan lose no time, but proceed to fortify positions to repel an army advancing on London; we should adopt wholly the methods of Continental Powers, ignoring the fact that our position as a nation is totally different from theirs, and may require a different system of defence.

Far better will it be for us to trust to our Fleet as our first line, as in former days.

First let us bring it up to the strength necessary to perform its duties, including the provision of an adequate reserve squadron. *Then*, as a second line, organize the troops we have, so that they may have some chance against the well-trained, and probably picked, men that would (if a landing were effected at all) be disembarked on our shores.

At present, while the talk is of fortifications, we have only 85,000 Regulars in Great Britain, of whom at least 20,000 are recruits. We are quite priding ourselves on being able to place one whole army corps, some 32,000 men, in the field. Let us give the Militia and Volunteers artillery, transport, and commissariat. Out of the nominal 350,000 surely 150,000 might be placed in a fit condition to take the field. With the aid of 50,000 Regulars, such a force should be able to deal with any invaders of our shores, who could hardly number over 100,000 men, and could not be well supplied with either artillery or cavalry.

If this system be followed, we shall have *one complete* system of defence. If it is not, we shall have a fleet insufficient for any purpose, and fortifications which will neither be sufficient in themselves nor have proper garrisons. Our resources will be frittered away on two

incomplete systems, neither of which will, in time of war, render the other any support.

It has been said that the Navy ask for an impossible superiority; that we ask for a superiority of our fleets over the French *after* Trafalgar. What we really wish is that we may be in the same relative position as we held when war broke out in 1803, allowing for the difference in modern ships, which has substituted certainty of movement for uncertainty.[1]

If this system be followed I come to my first conclusion from the preceding arguments:—

i. That even if the main fleet sustain a defeat, the state of the enemy will not be such as to undertake any organized territorial attack, in the face of a reserve or flanking fleet, and that consequently fortifications constructed to resist such an attack are unnecessary.

We now come to that part of the Fleet's duties which prevent an enemy undertaking any operation without first fighting an action. This may be termed the policy of evasion, and it may be remarked that in all naval history there is no case in which disaster has not overtaken those attempting it.

The French are the only nation sufficiently near to invade us in this manner.

The covering war-ships, without which the attempt could not be made,[2] must escape either from Brest or Cherbourg, or both.

If the blockading squadrons were properly constituted, they should know what force had eluded them within twelve hours.

The 1888 manœuvres are quoted against this view, but Admiral Baird's squadron was certainly not properly constituted for blockading. He had nothing like a sufficient number of fast small ships for in-shore work, and no use was made of mechanical mines. On the escape of three ships, Admiral Baird, not knowing the force which had escaped, had to raise the blockade. He feared for Admiral Rowley, who, if he was caught by a superior force, would, by the rules, be considered captured. In real war, under the same circumstances, Admiral Rowley could be relied upon, in case he was attacked, to hold his own in touch with the enemy for twenty-four hours, without suffering defeat in a decisive action, so long as he had sufficient speed.

Admiral Baird had no reserve fleet in England, and the conditions under which he blockaded, as regards distance from base and power of receiving and giving information, were far more unfavourable to him than they would have been had he been blockading Brest or Cherbourg.

The Commanders, had they been blockading these ports with a properly constituted squadron, could despatch after the enemy's escaped ships a slightly superior force, within twelve hours of their escape. I assume that they would know *when* the enemy's ships attempted to escape, and that two or three hours after daylight the

[1] On this subject *vide* Appendix A.

[2] See page 420.

next morning (if they had broken out in the night) their in-shore squadron would discover *what* ships had done so. With the remainder of their force they would maintain the blockade, having taken care to preserve their relative superiority over the enemy's ships left.

The escaped forces, if all went well with them, and they were successful in effecting a junction with their transports, would, if they attempted to land anywhere between Portsmouth and the Downs, be subject to interruption from ironclads in under six hours. In under twelve hours they would be attacked by a superior fleet, against which they could have no reasonable hope of success.[1]

What force could be disembarked in six or even twelve hours? If men and guns *were* hurried ashore in fear of hourly interruption, there would still be no time to land stores and ammunition in quantities sufficient for their purpose.

In twelve hours' time if his ironclads were defeated, consider what the condition of an enemy who had landed would be: in rear, all retreat, power of reinforcement, and supplies cut off; in front, the country devastated by a hostile population, an army waiting to fight for hearth and home.

Who can doubt the result? Who can even maintain that an enemy would run such risks, with other means open to him of damaging us?

I cannot think he would be so rash, in view of almost certain failure. I therefore conclude that:—

ii. Given an adequate naval defence, and proper organization of the land forces as a *second line*, no enemy would risk attempting an invasion under cover of war-ships which had evaded our main fleets. That, therefore, fortifications to meet such a contingency are superfluous, and should not be undertaken.

I will now proceed to those duties of the Fleet which I have termed iii (*a*) and (*b*), viz.:—

(*a.*) Patrolling trade routes.

(*b.*) Keeping open the approaches to commercial ports.

Whilst our trade over sea is large and vital to our interests, our enemy's will be small and immaterial to him. We must, therefore, have a safe-guard against his isolated cruisers, who may be outside our grasp at the beginning of the war, or who may entirely escape the vigilance of our blockade; and also more particularly against those small fast craft that may be fitted out for service in the narrow seas from commercial ports, either by the enemy's Government or by private enterprise.

Fortifications, outside the *rayon* of their guns, are no answer to such ships; cruisers are necessary for their destruction. Thus an enemy's ship could lie 15 miles off the entrance to a commercial port and destroy every merchantman that approached it; fortifications would be powerless to prevent her doing so. On the other hand, one of the C class of corvettes or "Heroine" class (unless for patrolling

[1] See Appendix B for combinations to illustrate and prove these points.

long distances), assisted by a couple of torpedo-boats, would be a sufficient answer to the majority of an enemy's cruisers. The point where the trade routes converge on a port, an enemy's most profitable field of adventure, would thus be denied to any but the heaviest class of his ships. If these ships are sufficient to protect merchantmen from capture by a certain force, they are also capable of defending the port against the attack of the *same force* under all ordinary circumstances.

Therefore I conclude that:—

iii. To a great extent ports are protected by those ships which it is necessary to provide for defending trade in their vicinity. That, in consequence, if it is a question of providing ships or forts, and both cannot be provided, the former should be preferred.

PART II.—*Cases in which Defence by the Fleet becomes Inoperative, and Attacks to which Territory could be subjected.*

From my conclusions in Part I it will be seen that, assuming we have maritime supremacy, the chances of territory being subject to attack are very small. Even if the enemy evaded our ships, the time he would have free from interruption would be short; but it must be borne in mind that if a place be entirely unprotected, though the time at his disposal may not exceed one or two hours, the damage inflicted in even that time may be irreparable.

The destruction of our great arsenals, with all their means of refitting ships, would be a most serious blow. Coal is a necessity both for men-of-war and merchantmen; indirectly, it is the life of the United Kingdom, for without it neither food nor raw material could reach us. In coaling stations abroad we might be seriously crippled by its wholesale destruction.

The risk, therefore, of blindly rejecting *all* passive defences is apparent; notwithstanding that our naval forces may be always superior, they may experience temporary reverses or evasions,[1] rendering shipping ports open to attack for a limited period.

Take, for instance, the case of the naval ports at home in the event of war with France. An enemy would, if he broke the blockade, get between twelve and twenty-four hours free opposite Portsmouth or Plymouth.[2] Knowing these ports to be unprotected, he would run great risk to destroy everything in them. The naval force patrolling the coast would be powerless against three or four modern ironclads, which force it is at least conceivable might break away.

Primâ facie, every port on the south coast would be subject to a similar *coup de main*. It would, however, only be worth the risk (of being cut off) in the case of the very large commercial ports and naval arsenals. The damage he could do other ports in the time, even if they were undefended, would not affect the course of the war to any appreciable extent.

A single fast cruiser, however, which had escaped with the view of

[1] Such as are considered in Appendix B.

[2] See Appendix B.

committing depredations on our commerce in the narrow seas, must, for these ports, be taken into account. Her career should be short; the patrolling cruisers along the coast, the vessel or vessels keeping open the port, and the torpedo-boats should render a good account of one or even two of such vessels. In the United Kingdom, if the enemy succeeded in defeating or even sinking the force mentioned, she would herself be badly crippled. The telegraph would bring reinforcements in a very short time, as the cruisers here would have to be numerous for the protection of commerce.

In the case of ports depending on *caissons* or dock gates, an enemy might run in and do enormous damage in half an hour, before a naval force could appear on the scene. Such a contingency must be guarded against.

The case of commercial ports and coaling stations on the trade routes abroad may be very different.

After the mobile force keeping open the port had been captured or sunk, the enemy, had he a single gun left fit to fire, and a small force to fight, could enter the port and coerce the inhabitants into supplying his wants, if it were unprotected. He would, in many places, have plenty of time to refit, before naval reinforcements could appear.

The attack to which naval arsenals *abroad* could be subjected must depend on the force which the enemy maintains within striking distance in time of peace. In proportion to that force they will be open to the same attack by invasion as the home arsenals. The time an enemy would get free would, however, be greater, on account of the greater distance our Fleet would be from its base, and the uncertainty attending telegraphic communications over sea.

Our possessions abroad are not, as a rule, on account of their distance from possible points of embarkation, liable to invasion or siege by land and sea. We would, therefore, for these places provide no reserve fleet, and, consequently, our main fleets, although superior, would stand more chance of reverse than those at home, which would be capable of speedy reinforcement.

Except in the Mediterranean, large naval forces are not maintained abroad by the European Powers.

The largest force is in China, where France and Russia combined maintain two armoured cruisers, three or four cruisers, and several smaller vessels. Our naval force there is sufficient to cope with them. Holland also maintains a strong force with headquarters at Batavia. China and Japan have modern squadrons; they may, however, be set off against one another, as, whichever side one takes, the other will probably take the opposite.

It must be borne in mind that ports over 1,500 miles from those of an enemy are not open to ironclad attack. Except ourselves, no European Powers have ironclads possessing a coal endurance of over 4,000 miles at 10 knots. Such vessels would not be risked on distant enterprises.

From these considerations I draw the following conclusions:—

iv. Fixed defences are desirable for naval arsenals and great com-

mercial ports at home, to hold them against a dash made by ironclads which had succeeded in evading our blockade until such time as we could depend upon overtaking them with superior naval force.

v. Similar defences are necessary for naval arsenals abroad. They should be on a much smaller scale than those in iv, as not being open to attack from a heavy force despatched from Europe.

vi. Coaling stations and commercial ports abroad should be defended against one or two fast cruisers which had succeeded in defeating the naval force keeping open the port. Allowance should be made for their having already fought an action.

vii. The case of smaller commercial ports at home must be considered according to their relative importance, observing that an enemy's cruiser could blow in dock gates and do much damage in half an hour.

PART III.—*Nature of Fixed Defence considered Necessary, having regard to Conclusions in Parts I and II.*

I have (in Parts I and II) pointed out the necessity of having our sea communications perfect. In any system of defence, whether by ships or forts, good communication should exist along the coast with the naval ports and with the capital. As I have concluded that in our case the defence will be principally by ships, numerous signal stations will be necessary in telegraphic or telephonic communication with one another. Such stations would always be liable to a light attack of an enemy who wished to cut our coast communications as part of some pre-arranged *coup de main*.

The possibility of such being accomplished by a couple of boats' crews or torpedo-boats could be guarded against by having the dwelling places of the Coastguard suitably built to resist musketry. But attempts to spend money on any more elaborate defence should be very jealously guarded against. The heavy expense precludes the use of underground cables; the main lines of wire could, however, at small extra cost, be retired about 7 miles from the coast line; the wires from each station should lead direct inland to them, and the junctions should, where possible, be near a railway. This would allow of troops being concentrated in sufficient time and numbers to prevent a small party capturing a Coastguard station, following up the wires, and cutting the main line. This service would be one properly performed by the local military Reserve forces. The first duty of the Coastguard on being attacked would be to telegraph to their junction, so that proper precautions might be taken. Taking the wires from a station underground for a *short* distance or over inaccessible ground would tend to throw an enemy out in such an enterprise.

In dealing with the ports spoken of in Part II, as requiring local fixed defence, I shall divide them into four classes, viz.:—

(*a.*) Naval arsenals and great commercial ports at home (the former including both public and private building yards).

(*b.*) Small coaling stations and commercial ports at home, not included in (*a*).

(*c.*) Naval arsenals and great commercial ports abroad.

(*d.*) Coaling stations and commercial ports abroad not included in (*c*).

My conclusions in Parts I and II, if correct, enable me to assume that these ports want protection against a dash made with the object of doing as much damage as possible in the time, that this will be limited by the operations of our ships, and that we have no reason to fear their being besieged by land and sea.

The defence should consist of two parts, viz.:—

(*a.*) The active defence, consisting of all ships in the vicinity of the port, and torpedo-boats.

(*b.*) The passive, which only comes into play on the failure of the active defence. It consists of (1) mines, (2) water defence, and (3) guns.

With (*a*) I do not propose to deal, except in relation to the probable condition the enemy would be in after an action, before he could engage the passive defences.

All ports are particularly liable to an enemy's ships entering and blowing in dock gates and destroying stores, after having run the gauntlet of the gun defences.

This can only be effectually guarded against (in large harbours with fairly narrow entrances) by a mine-field, and constant vigilance, both on the part of those ashore, and also any active defence that may exist.

Electro-contact or observation mines should be used if it is not desired to close the port. The latter are best, as being safest for friends. A marked channel should be left, and a pilot would always be necessary.

This mine-field would require protection to prevent its being countermined for the passage of ships. This should consist of

(*a.*) Quick-firing or light guns and machine-guns sweeping the field.

(*b.*) Electric lights for the detection of an enemy's countermining or torpedo-boats.

(*c.*) Guard-boats to give ample warning, and, if possible, deal with the enemy's boats before they can get on the field.

This defence is of itself sufficient if an enemy cannot spare more than four hours, providing that it is sufficiently advanced to prevent his undertaking a distant bombardment. This can be guarded against by having rifled howitzers mounted in suitable positions in advance of the mine-field. As they can be placed behind any interposing high land, or in earthworks, they are very cheap. In conjunction with the Watkin range- or position-finder, they are also very efficient. Ships could not remain at anchor where such ordnance was mounted, and no distant bombardment could be effective without their being so.

Had an enemy more time at his disposal, he could enter the port by first silencing the covering quick-firing guns of the mine-

field and then countermining it. A force of two cruisers and a depôt ship would, however, be necessary to undertake this.

To meet this contingency in ports open to it, a main gun defence must be provided in advance of the mine-field. Its nature must depend on the force by which it is considered the port is liable to be attacked; it must be so placed that an enemy cannot silence the guns covering the mine-fields without having the guns of the main defence to deal with first.

To prevent surprise, every ship entering the port should be made to stop outside the defence. One guard-boat should board her, another lie off at some distance. If all was right, the first boat would signal to the defences. The Officer of the first boat would pilot friendly vessels in. Ships not complying with the port regulations would have to stand their chance of being fired upon or blown up. This would complete the arrangements for the defence of the sea side.

Defence for the land side should be merely sufficient to prevent an enterprising enemy attempting an attack with a small force on the rear of the sea defence. With few exceptions, defences should not be erected to withstand a siege, and positions for heavy guns are unnecessary.

The late Major Walker has suggested suitable infantry keeps. In view, however, of the difficulty an enemy would have in landing even the lightest artillery, the utility of the provision of bomb-proof appears doubtful.

As the attack to which ports are liable can only be of short duration, defences need only be sufficient to delay it until relief can be afforded by adequate naval force Care should be taken that they are of a nature that will require the smallest possible garrison. Guns should be mounted in the most modern way to ensure their requiring small gun detachments. Men are more usefully employed as a mobile force, whether ashore or afloat, than in permanent fixed positions.

In dealing with the four classes of ports of my essay, I have in the following pages assigned a typical armament to each class.

Naturally, local conditions would modify this, and no hard-and-fast line could be drawn without considering each port of the Empire separately. I regard this as a technical question, not within the scope of an essay on a general subject. The details concerning the mounting and disposition of the guns, and the positions of the mine-fields, I look on in the same light. These reasons, combined with the fear of making the essay too long, have induced me to dispense with anything more than a general survey.

(a.) *Naval Ports and Great Commercial Ports at Home.*

From the conclusions drawn in Appendix B, it is apparent that an enemy can only get twenty-four hours opposite any of these ports free from the interruption of a superior force. He will have an inferior force in observation in under twelve hours.

The force which might escape from his ports must be proportional to the force blockaded there. It is at least unlikely that more than half of it could so escape. If the whole got out and evaded the blockaders, the latter could only fall back on the English coast, and await certain information, which, by telegraph or cruiser, or a combination of both, should not be long in reaching them. Consequent eventualities have been already fully discussed in the first half of Part I of this essay.

Taking into consideration the actual number of ironclads possessed by foreign Powers, and the difficulties in their way, it may be, I think, safely laid down that not more than four would escape.

Even should they be more numerous, they would hardly be used to bombard or raid a port, with a superior hostile force within twenty-four hours of them. Both the ammunition and coal they carry are limited, and although they might do great damage, yet the risk of being cut off with exhausted supplies of either must remain a great deterrent.

The defence should therefore be as against four ironclads for a period of forty-eight hours, which allows a good margin of time. This would be sufficient to compel the largest force to expend a large amount of ammunition, the danger to them of which has already been pointed out.

In arranging such a defence, credit must be taken for the guns ashore, for the following points, as against ships:—

(1.) They can, and the ships cannot, always know their distance accurately, by either the Watkin depression range-finder or position-finder.

(2.) The heavy guns can be almost absolutely protected against gun fire, as there is no limit to the weight of their protecting armour, or the thickness of their earthworks.

(3.) They can have an unlimited supply of ammunition.

(4.) The garrisons can be constantly reinforced.

If we take four ironclads, accompanied by cruisers, we find their armament to be somewhat as follows:—

12 71-ton guns,
110 4-ton guns,

with a proportion of quick-firing and machine-guns.

The following guns, all able to bear on an enemy at the same time, would be a sufficient answer to such a force, and would hold a much larger one in check for twenty-four hours:—

6 12-inch howitzers,
6 13½-inch guns (68 tons),
30 6-inch B.L. or 15 100-pounder quick-firing,

and a proportion of smaller quick-firing and machine-guns.

The port should also have the mine defence, previously mentioned, covered by the electric lights and quick-firing guns. Guard-boats

should also be provided, as also the light land-side defence already mentioned.

The ports to be included in the general scheme of defence are as follows:—

Leith (Firth of Forth).	Portland.
The Tyne.	Milford.
The Thames.	Liverpool.
Portsmouth.	The Clyde.
Plymouth.	Queenstown.

Malta and Gibraltar, though strictly speaking not home ports, can be best treated of here, as they must be the subject of special consideration.

In a big war it might be necessary to abandon the Mediterranean and Suez Canal routes to the East, especially since the opening of the Canadian Pacific route. By blocking the Suez Canal, and having a force at Suez to keep it blocked, we could prevent the egress of an enemy's ships by an adequate squadron at Gibraltar. This would require a far smaller force (see Appendix A) than would be necessary to maintain the command of the Mediterranean, and the safety of our sea-borne trade to the East in it.

In this event Malta would be open to a regular investment, and should be fortified accordingly.

Gibraltar being in foreign soil and coveted by many, great risk would be run to capture it. If strongly defended, it might be of great help to a squadron stationed there for the purpose of closing this egress from the Mediterranean. Taking this, its natural advantages, and the money that has already been spent into consideration, I am of opinion that it should be in the position of a strong first-class fortress. A good flotilla of torpedo-boats should also be organized there.

(b.) *Small Coaling Stations and Commercial Ports at Home not included in* (a).

It has already been pointed out that where the ports are comparatively small an enemy would not run the risk of having his ironclads cut off by attacking them. It would, however, be within the province of one or two fast commerce-destroyers, detached from the enemy's main fleet, to attack the smaller commercial ports (*i.e.*, ports whose destruction would not affect the course of the war by crippling the resources of our ships).

Our patrolling cruisers should, as a rule, be able to deal with such vessels, and a very light defence representing a delay of about six hours would be quite sufficient.

Cruisers, as a rule, have no guns heavier than our own 6-inch, and even if they had, our 6-inch is still heavy enough to attack the majority of them with.

The mine-field, with quick-firing guns, electric lights, and guard-

boats, would be sufficient to keep a port safe for six hours. To prevent distant bombardment, three or four 9-inch rifled howitzers should be mounted in advanced positions. In some cases the addition of four 100-pr. quick-firing guns might be advisable. Land-side defence should be of the very smallest description. Works of a permanent nature are hardly necessary. More than 300 men could not be landed, and a force amply sufficient to deal with them (about 600 men) should be easily concentrated in a very short time. The ports for which such a defence is necessary are as follows:—

The Humber.	Londonderry.
Yarmouth.	Waterford.
Dover.	Limerick.
Alderney.	Barrow.
Falmouth.	Tees approaches.
Bristol Channel ports.	Wear approaches.
Holyhead.	Firth of Tay.
Dublin.	Firth of Moray.
Belfast.	

Other ports I consider it would be better to leave unprotected. If there was no defence, he could have no excuse for bombarding towns on the sea-board.

(c.) *Naval Arsenals and Great Commercial Ports Abroad.*

These ports are not within striking distance of battle-ships. An examination of the force maintained by European Powers on foreign stations shows that at the most two armoured cruisers could execute a *coup de main* against them.

Against any prolonged operations the Fleet are a protection, on the principles that have been already discussed in Parts I and II. The distance from our bases to the enemy's ports are much greater, however, abroad than in the United Kingdom. The result of this would be that an enemy's main force having evaded ours would have a longer time free from interruption. They would still have to deal with a local naval defence keeping open the port, which might also be reinforced by cruisers patrolling the routes leading to it. The local force referred to would be such as exists in Hong Kong, which may be taken as typical, viz., H.M.S. "Wivern," four 125-foot torpedo-boats, two 85-foot ditto, two 65-foot ditto, and two river gunboats; this force might be strengthened in war by the addition of either one of the C, or "Heroine" class of corvettes. No reserve fleet is, or is likely to be, maintained in foreign waters, with the exception of Australia, where the newly formed Australasian squadron may be looked on in that light, and therefore as a protection against invasion on the principles already laid down.

Where our possessions abroad are small in area and isolated in position, simply forming links in our chain of communications, their protection in the event of disaster to the naval forces in the sur-

rounding waters is on a different footing from that of the United Kingdom, or other places of large area and sea-board. In these cases, fortifications would undoubtedly be better than the provision of a reserve fleet. But in any case defence against a prolonged attack would be a mistake.

If a port is to remain of any service it must be relieved by a naval force despatched, if necessary, from home. If it is closed to us, it would be of no further use, and should be allowed to fall into the enemy's hands rather than fortify it heavily in peace against the contingency. Such heavy defences are not only unnecessary in themselves, but engender also a false sense of security; the effect of this might be the reduction of the naval force in foreign waters to numbers insufficient for the protection of trade and communications, functions which no fortifications can perform by sea.

The following gun-fire would be a sufficient defence for the ports under consideration, viz.:—

2 9·2-inch B.L. guns.
4 100-pounder quick-firing guns.
5 9-inch howitzers.

The mine-field, &c., to be provided as in the naval ports at home.

The following are the ports for which a defence of this type is recommended.[1]

Kurachi.	Sydney.
Bombay.	Hobart.
Colombo.	Cape Peninsula.
Calcutta.	Mauritius.
Rangoon.	Halifax.
Singapore.	Bermuda.
Hong Kong.	St. Lucia.
Albany.	Esquimalt
Melbourne.	(Vancouver's Island).

(d.) *Small Coaling Stations and Commercial Ports Abroad.*

Ports which have no docks or great commercial interests, or which *must* be near the protection of a comparatively large naval force, do not call for so large a defence as the ones mentioned in (c).

They should have the mine-field, with its covering lights, quick-firing guns, and boats, where applicable. Beyond this the defence must vary with the port; the gun power should consist of from two to six 100-pr. quick-firing guns (or equivalent gun power), and from two to six 8-inch or 9-inch howitzers. The land-side defence should be of the smallest description.

The following are the ports included in this category:—

[1] In ports where submarine defence is inapplicable, a heavier gun defence would be needed.

Perim.	Fiji Islands.
Aden.	Sierra Leone.
Penang.	Ascension.
Labuan.	St. Helena.
Sandakan.	Mombasa.
Auckland.	Jamaica.
Adelaide.	Falkland Islands.
Brisbane.	Wellington, N.Z.

Cyprus, Port Said, and Suez have been purposely omitted. Should we intend to keep open the Suez Canal, or annex Egypt, these places will require special consideration. As it is, they do not come within the scope of this essay.

PART IV.—*Control and Personnel of Coast Defence.*

The want of organization of the fixed defences of our coasts, both at home and abroad, has been for many years the subject of outspoken adverse criticism, both from our own countrymen and from foreigners. The prevailing opinions on the subject may be fitly summed up in the words of Lieutenant Colwell, of the United States Navy, an unprejudiced observer, who says:—

"The coast defence of Great Britain is notably the most inefficient of any of the great European Powers. Owing to the divided control, lack of co-operation, absence of digested schemes for mutual support, and the mixing of naval and military duties, the defence is unwieldy in its administration, unprepared for sudden work, and labours under the disadvantage of placing military men in situations outside their legitimate sphere of action."

Present efficiency cannot, therefore, be urged as a reason against changes in the future.

In our system of defence, our 1st line, the Navy, and its bases and points in the lines of communication over-sea, are under separate control.

Our Navy corresponds to a Continental field army, and our arrangement is much the same as if Germany, for instance, had her frontier fortresses and lines of communication under a different department of the State from her Army Corps.

If the conclusions at which I have arrived in the preceding portions of this essay are correct, the Army can only form part of this 1st line,[1] when the operations of the Fleet (strictly defensive) have so far secured the command of the sea as to admit of the delivery of a territorial counter-blow. In this stage of a war, the Navy would be powerless without the co-operation of the land forces. Until this state has been reached, the Navy can only be looked on as a defensive force. Masking an enemy's vessels on the sea, in peace-time neutral and free to all, and subject to no special nation's jurisdiction, can by no possibility be considered as offensive operations. A mistake is therefore made when we hear it occasionally stated that the Army

[1] Except in the case of the land frontiers of India and Canada.

frees the Navy for offensive operations, the fact being that the direct opposite is the case.

The only places that require fortifications are those, as I have already shown, which form part of the defence by the Navy; it, therefore, appears natural that the control of their defences should rest with that force; a misconception as to how far they can be covered by it is sure to, and does, in fact, arise, where their defence is controlled by a totally different authority. Thus, costly fortifications have been constructed, involving a large waste of both men and material; the former would, in most cases, be of much greater use as part of a field force, ready either to meet the improbable contingency of a hostile force landing, to embark at short notice, to deliver a counter-blow, or as reinforcements to those ports of our Empire which have land frontiers.

I therefore conclue that—

viii. The defence of all naval bases and commercial ports should be under the control of the Naval Administration, and that, consequently, the charge for them should be borne on the Navy Estimates.

This course has already been followed in the case of naval ordnance, without at present any change taking place in the personnel. Referring to this subject, Lord George Hamilton, in his official Memoranda on the 1891–92 Estimates, says:—

"There are Officers in both Services who believe that this transfer of duties from the Army to the Navy might with advantage be pushed much further, and measures should at once be taken by which the Navy should immediately undertake the defence of the great naval ports, and be, in time of war, responsible for the safety of the base of their own operations. I admit that, if such a change could be carried out, it would tend to secure *unity of action and responsibility*, and would, in any emergency, secure at the great naval ports the *rapid utilization of all available resources*, for whatever movement the exigency of the moment might require."[1]

Sir William Jervois, from his position as a distinguished soldier and an ex-Colonial Governor, well qualified to judge, advocates the Navy taking over complete control.

In the unlikely event of invasion or shore operations, the naval personnel would, where necessary, serve cheerfully, as they have done before, under the orders of soldiers and the War Ministry.

One or two instances will show how much unity of action is at present wanting. The Army have made little or no provision for guard-boats for the mine-fields; they rely upon the Navy, who have no arrangements. The Army have no Officers capable of undertaking the organization and command of such a force; such should be both trained to the sea and to arms, combinations only found in the sea service; the work requires careful training and considerable practice in peace.

No arrangements again are made for the co-operation of torpedo-boats, although, in most ports, they are provided. Without such,

[1] The *italics* are mine.

boats driven in to take shelter in a harbour would run a great risk of being sunk by their friends' guns.

In further support of this view of the question, it should be noted that the navies of every important European Power have charge, or partial charge, of the coast defence.[1]

Apart from the question of control and estimates, is that of the provision of the personnel. As has already been mentioned, naval ordnance has been placed under the control of the Admiralty, and the cost borne on the Navy Estimates, without any change at present in the personnel. It is, however, desirable that men paid by, and under the direction of, one department of the Administration, should, if possible, be trained by that department, and, as a rule, spend their life in its service. By this means only can they be sure that those employed are such as they consider efficient for the work. In a sphere of naval operations, such as the defence of our distant trade routes, where the Army *as* an Army have absolutely *no raison d'être*, the naval Commander should have the chief control of his base and the points along his lines of communication. Such an arrangement need *not entail* his remaining at any one of these points, although in some cases it might be convenient for him to do so; the Commanders of the strong places should be simply under his orders.

There appears to be no reason to suppose that a naval Officer is not as well fitted to command a coast fortress as an infantry General; the latter has technical advisers under him,[2] the former would have the same. On this point the opinion of an Officer of Royal Artillery is very valuable. Lieutenant-Colonel Walford,[3] referring to such a Commander, says:—

"There appears to be no reason why such a command should not be entrusted to an Officer of either Service."

From these considerations I believe that it would be better to provide a purely naval personnel for our coast defences.

The active or sea defence, namely, such ships and torpedo-boats as may be detailed to keep open the port, I do not intend to touch on, as it must obviously be purely naval. The passive defences, divided into three parts, are as follows:—

(*a.*) The main gun defence.
(*b.*) The mine defence.
(*c.*) The land-side defence.

The personnel of (*a*) could be well supplied by the Royal Marine Artillery, and be commanded by an Officer of that arm. Such Volunteers and Militia as are now told off to assist in this defence could be transferred to the Admiralty. The same arrangements could be made with native troops, who in this case would eventually be officered from the Marines.

Marine Artillery, from their sea training, should be far better able

[1] See Appendix C.
[2] Viz., Officers Commanding R.A. and R.E.
[3] Lecture R.U.S.I., January 22, 1890.

to understand and deal with attack by ships than shore gunners; the R.A., for the most part, are ignorant of the construction and mobile power of men-of-war, and are deficient in the faculty of rapid identification of such ships. Their system of officering is very bad. Many junior Officers are sent to garrison batteries who hate the work; their only idea is to get transferred as speedily as possible into Field or Horse Artillery. How can it be expected that such men will take any interest in the slow movement and want of dash of a coast battery? Contrast men shut up in an earthwork, with a 6-inch gun and their coats off, with the glitter and dash of coming into action with a horse or field battery, to say nothing of the far better chance an Officer has of seeing active service with the latter branches. If this defence is to be kept by the Royal Artillery, the Officers, as well as the men, must be specially trained for that purpose.[1]

We now turn to the mine defence, which is, at present, so far as the mines and lights are concerned, in the hands of the Royal Engineers, or rather a special corps of Submarine Miners, who also have charge of the auto-mobile and dirigible torpedoes.

The covering guns, quick-firing or otherwise, are worked by the Royal Artillery. The guard-boat or water defence does not exist in any organized condition; a naval Officer should in any case supertend it.

This section of the defence would then be under three heads, and three sets of Officers, an arrangement hardly likely to lead to unity of action, even when the functions of each and the extent of their commands are very clearly laid down.

As regards the Submarine Miners, there would appear to be no great difficulty in transferring them to Admiralty control; submarine mining is their only duty, and if the coast defence were turned over, the Army would have no further use for them. The present arrangements cannot, however, be called perfect. The men have a "long shore" training in pulling boats and steam launches. The Officers do not, however, acquire the habit of commanding on the water; with a few exceptions they are quite incompetent to do so. Sailors will work on the water during weather which will confine submarine miners to dry land, their proper element. The difficulty with the men can be obviated by enlisting merchant seamen; that of the Officers cannot be so easily got over. To see them directing any work on the water is not, as a rule, edifying to a sailor.

In some of the bigger mines, the want of a responsible seaman in charge was greatly felt. This was met by enlisting men with "Masters' certificates," of course on the promise of rapid promotion and a higher rate of pay; it is needless to say that these inducements would not be likely to tempt the better classes of Officers in the mercantile marine. In a boat of 150 tons displacement with one of these men in change, an Officer of Royal Engineers, though really in command, would find it very difficult to interfere with the dicta of his

[1] The above was written in May, 1891. Since then "the right of fall" has been abolished and Officers are now appointed to the Garrison Artillery for their service career.

subordinate; he would be in a most undesirable position, as the latter could, at the most, be only a Warrant Officer.

These objections do not apply to torpedo Officers in the Navy; they are already acquainted with the more elaborate system of mining used by the Royal Engineers, which *may* be necessary on account of its permanent nature, and the means existing in it for accurate testing. The naval system is a rough and ready one, which might not be good enough for mines which it is desired shall be submerged for a long period. If torpedo Officers had a longer course in the "Vernon," there would be no doubt of their being perfectly capable of doing the work, and this the Royal Engineers themselves acknowledge. The course at the Naval College might be shortened proportionally for all but men of the greatest talent. As the Navy already work their own electric light and auto-mobile torpedoes, this part of the defence would be nothing new to them. The number of torpedo Officers would have to be largely increased. They should spend at least half their time in sea-going ships. At present they do no more: out of forty-eight Lieutenants, twenty-one are employed in harbour or shore appointments. There would be no difficulty in arranging it, as it would be very advantageous to have a torpedo Lieutenant in many ships which do not now carry one. He could always in the smaller ships take his ordinary turn for duty.

Seamen are quite as capable of handling quick-firing guns as men of the Royal Artillery, whether they are in fixed positions or on field carriages, as long as in the latter cases they are used without horses. In the event of the whole mine defence being undertaken by seamen, the number of torpedo men who would require more training than they at present receive would be very small. The bulk of them would learn all that was necessary during a month's additional training. A few men similar to the present leading torpedo men and torpedo instructors would receive a more advanced course, which would not take them more than three months longer than the course they at present go through.

The most important objection raised against seamen undertaking this defence is that they would be withdrawn from the service of the Fleet, and, losing their identity as sailors, would become as much a special corps as the Submarine Miners, whose training would be less expensive. I believe these fears to be quite groundless. These men would be just as useful in a seaman's capacity after they had qualified in torpedo as are the present torpedo men; in the latter capacity they would be of far more use. To prevent their always serving on shore, they should be in sufficient numbers to admit of at least half of them being afloat, as part complement of ships of war, where they would be employed at the electric light, torpedo tubes, and quick-firing guns, and at mining work when required. It might be found desirable for the men to divide these functions into two specialities, as, for instance, mining and electric light forming one, mobile torpedoes and quick-firing guns the other.

If a vessel of the "Cruiser" class were stationed at our ports, it would be advantageous, not only for these men, but also for the or-

dinary crews of harbour ships, who are much more likely to lose the instincts of a sailor, serving as they do in stationary mastless ships, with none of the useful boating work which would be part of the torpedo corps' every-day duty.

The entries for the Navy would have to be increased, which would be a great advantage, for the additional men under training would be available to *man our ships* in time of war, as in that event all discharges would, of course, be suspended.

I am, therefore, in favour of the seaman class doing the mining; firstly, because they would be more efficient, and, secondly, because the number of men available for sea service on the outbreak of war would be largely increased.

If, as an alternative, the Submarine Miners, as they stand, be placed under Admiralty control, I would urge the necessity of recruiting them in the future from a seafaring population, and of officering them with Lieutenants in the Navy qualified in torpedo. They could still retain their character of a separate corps if considered desirable, although I believe the previous plan would be far the most efficient.

The defences of the land side should be entrusted to the Royal Marine Light Infantry, which is as good as any in the world. In the few places where field artillery is required, it could (as in foreign services) be supplied by the War Office, and the cost borne on the Navy Estimates. Where mountain artillery is necessary, the Royal Marine Artillery should provide the personnel.

To summarize my proposals:—

(*a.*) The naval base and all points in the lines of sea communications to be under the supreme military[1] control of the Naval Commander-in-Chief.

(*b.*) The Commander of each of these posts to be either a naval or military Officer.

(*c.*) The personnel of these posts to be as follows:—

Main gun defence.....	Royal Marine Artillery.
Mines, lights, covering quick-firing guns, torpedoes, and water defence.....	Torpedo men from the Royal Navy.
The land defence.....	Royal Marine Light Infantry.

All the above under their own Officers.

In case of invasion, men not wanted in coast fortresses, or more urgently needed as a mobile force, could be formed into marine brigades and divisions and turned over to the War Office, under the command of a marine Officer.

Fortress engineers would be necessary to look after the construction and repair of shore defences, on both the land and sea sides. Three means of providing the personnel of such a force suggest themselves, all of them equally good:—

[1] As opposed to civil, with reference to civil populations.

(*a.*) To use the Royal Engineers under the same conditions as suggested for the field artillery.

(*b.*) To allow a certain proportion of Officers Royal Marine Artillery to go through an advanced course of fortification, and to use civilian labour.

(*c.*) To have, as suggested by Sir William Jervois,[1] a special corps of Royal Marine Engineers.

Finally, to supplement the personnel, I should urge that all civilian employés of the Government, particularly those whose work is of a seafaring life or "long shore" nature, should belong compulsorily to a Reserve Coast Defence corps, receiving extra pay whilst being drilled or embodied. This would include men employed in buoyage, lighting, customs, water police, and all the *established* personnel of our dockyards. As far as compatible with the duties, these billets should be filled by ex-soldiers or sailors.

The communications of the coast are already in the hands of the Navy with the exception of Lloyd's stations. Arrangements should be made to enable the Admiralty to take them over altogether in war time.

The Coastguard and Revenue cruisers should be vessels efficient for local or coast defence. All the garrison in turn should be exercised afloat, particularly in firing.

The changes advocated are undoubtedly very great, but I can see no means of obtaining the necessary unity of action without them, or something approaching them.

They should be accomplished gradually, so that ample opportunity could be afforded of observing whether the scheme was working successfully. If it was, it could be pushed to its limit; if not, the attempt could be modified or abandoned, and no harm could be done.

The first step would be to appoint a naval Officer to command the *active* defence of each port. He should be on the staff of the General, and his adviser in all naval matters. Under him should be a naval Officer to organize and command the water defence of the mine-field; his only other superiors would be the Commander of the mine defence and the Commander of the fortress, unless the Naval Commander-in-Chief be given control. These appointments should be made to all ports, whether their defence is or is not to be turned over to the Navy.

Defence by the Navy should first be tried in two ports, one abroad and one at home, let us say, Hong Kong and Portsmouth. For service in these places gradually increase the number of torpedo men, increasing the entries of seamen and decreasing those for the Submarine Miners and Coast Brigade Royal Artillery proportionally. When sufficient men had thus been trained, change *half* the personnel, seamen supplanting half the number of Submarine Miners, and half the Royal Artillery employed at the covering quick-firing guns. After a certain period, allowing time for the first half to acquire the necessary local knowledge, complete the change. The Navy would then have provided the complete personnel for the mine-

[1] "Home Rule for the Navy."

field, mobile torpedoes, electric lights, covering quick-firing guns, and water defence. Next, gradually replace the Coast Brigade Royal Artillery by Royal Marine Artillery, stopping enlistment and entry of Officers for the former and increasing them for the latter. When these changes were completed, a naval or marine Officer should be appointed to command the fortress, under the supreme control of the Naval Commander-in-Chief.

The charge of buildings, works, and stores could then be transferred from the Army to the Navy, and the whole cost of the garrison be placed on the Navy Estimates. After this, Royal Marine Light Infantry could be gradually substituted for Infantry of the Line, following the same course as regards entry and enlistment as for the Royal Marine Artillery. The change should then be allowed to work for two or three years. No great derangement in the scheme of defence would take place if it was effected in ten years; in twelve it would be in full working order.

If successful it could be extended to the whole sea-board of the Empire, which could be done with greater rapidity, as a nucleus accustomed to the work would already exist. The further extension would not take more than eight years. Thus in twenty years from when commenced, the change would be completely effected.

This scheme *partially* carried out would be better than not at all. The vital points I consider to be:—

(*a.*) That the Admiralty has control.

(*b.*) That the Naval Commander-in-Chief should be in chief command.

(*c.*) That the mines and their *water*-defence should be managed by seamen.

The other points, though desirable, I believe to be of less importance.

Conclusion.

In dealing with our coast defence, I have attempted to show,[1] and I hope successfully, the *primary* importance of our Navy: that it is our true first line: a defence both against the invasion of England, and of her very life, the sea-borne trade. The large armies and heavy coast fortifications of Continental Powers have been the red herring drawn across the track, diverting attention from our proper defence. In war is it good policy to wait on your frontier till attacked? The best authorities answer no, yet that is exactly what we must do if our Navy is not strong enough. The sea is our greatest highway; free to all in peace, it must be secure to us in war as having infinitely the greatest interests on it. On the course of a big naval war, land defences can have little or no bearing. No territorial attack can be made without naval war, which is the only one we can be forced to take part in.[2]

Before any local defence is undertaken, we must therefore make

[1] See Appendix D, "Summary of Conclusions."

[2] With the exception of India and Canada.

the Navy strong enough for the work it will be called upon to perform. Attack by sea must be met *on* the sea, a truism well understood by our forefathors, commencing with Sir Walter Raleigh, or even earlier, but seemingly, by many, lost sight of in these latter days.

I cannot claim originality for my opinions in the preceding pages. I humbly share them with many distinguished naval Officers, from whose speeches and writings I have been content to learn.

I cannot conclude this essay better than by quoting the words of three of these—three Admirals of the greatest experience, whose opinions are justly respected by all:[1]—

"Without any desire to question the sums annually granted by Parliament for the maintenance of the Services, we cannot but note the disproportion in the appropriation when the magnitude of the issues involved is taken into consideration.

"It would, in our opinion, be far more in consonance with the requirements of the nation by the provision of an adequate fleet to render invasion an impossibility, than to enter into costly arrangements to meet an enemy on our shores (instead of destroying his armadas off our shores), for, under the conditions in which it would be possible for a great Power to successfully invade England, nothing could avail her, as the command of the sea once being lost, it would not require the landing of a single man upon her shores to bring her to an ignominious capitulation, for by her Navy she must stand or fall."[2]

Appendix A.

Force necessary for Maritime Supremacy.

The following table shows the force considered necessary by Captain (now Admiral) Cleveland and Lieutenant Bradford, respectively, for naval supremacy. The third line shows the mean of both.

[1] Admiral Sir William Dowell, Admiral Sir R. Vesey Hamilton, and Vice-Admiral Sir Fred. Richards.

[2] Supplementary Report of the Committee on the 1888 Manœuvres.

Battle-ships.	Belted or protected cruisers.	2nd-class cruisers.	3rd-class cruisers.	Torpedo gun-vessels.	Coal-ships.	Store- and ammunition-ships.	Torpedo depôts.	Coast-defence-ships.	Gun-boats.	Mine-boats.	Torpedo-boats.	Telegraph-ships.
72	47	82	108	90	20	10	9	52	53	114	184	—
83	15	103	69	38	—	—	6	—	59	—	196	4
78	31	93[1]	89[2]	64	20[3]	10[3]	8	52	56	114	190	4

This allows for war against the two Powers and for keeping the Suez Canal route open and the trade in the Mediterranean protected. If that was not done (as suggested by Captain Cleveland) the Suez Canal would be blocked, and the Mediterranean blockaded from Gibraltar. This would require a less force by 12 ironclads, 10 belted or protected cruisers, 10 2nd-class cruisers, 6 3rd-class cruisers, 12 torpedo gun-vessels, 4 coal-ships, 2 store- and ammunition-ships, 2 torpedo depôts, and 12 torpedo-boats. The force thus required is shown in the first line of the following table: the force we shall have in 1894 (approximately) in the second:—

Battle-ships.	1st-class cruisers.	2nd-class cruisers.	3rd-class cruisers.	Torpedo gun-vessels.	Coal-ships.	Store- and ammunition-ships.	Torpedo-depôt-ships.	Coast-defence-ships.	Gun-boats.	Mine-boats.	Torpedo-boats.	Telegraph-ships.
66	21	83	83	52	16	8	6	52	56	114	178	4
64[4]	15	51	65[5]	46[6]	—	—	2	16	72	—	86	—

[1] A proportion could be armed mercantile auxiliaries.
[2] A proportion could be armed yachts or tugs.
[3] Could always be extemporized.
[4] Battle-ships and armoured cruisers.
39 3rd-class cruisers and 26 sloops.
[6] 27 torpedo gun-boats and 19 gun-boats 1st-class.

Appendix B.

Examples of Enemy's Ships escaping from Blockaded Ports to the South Coast, with means proposed to check them.

Let us take Brest and Cherbourg as examples.

Call the British squadrons blockading these ports A and B respectively. Call the blockaded squadrons C and D, and the ships which have evaded the blockade, *c* and *d*. Call the ships detached from A and B to pursue these latter *a* and *b* respectively. Call our Reserve Squadron, stationed in the Downs, R.

If A's and B's cruisers did not succeed in keeping touch with *c* and *d*, and *a* and *b* had no certain knowledge of their whereabouts or ultimate object: then within 12 hours at the outside:—

a would proceed to Plymouth, 11 hours' steaming at 11 knots.

b would proceed to Portsmouth, $8\frac{1}{2}$ hours' steaming at the same speed.

When the Commanders found that ships had evaded their blockade they would send:—

One cruiser at 15 knots from Brest to Plymouth, from which place the coast and R would be warned by telegraph in 8 hours.

One cruiser at 15 knots from Cherbourg to Portsmouth, who would perform the same duty in 6 hours.

When the force of the escaped ships was ascertained, second cruisers belonging to *a* and *b* would proceed ahead and communicate with Plymouth and Portsmouth in the same times, or 3 hours and $2\frac{1}{2}$ hours respectively before *a* and *b* could do so.

On *a*'s and *b*'s arrival, they would, by means of the telegraph and coast stations, be in communication with each other, with R, and with every ship or boat along the coast.

Now, suppose an attempt to land in the vicinity of Plymouth.

Steaming 12 knots,[1] *c* and *d* would arrive there 10 hours after escaping. In 13 hours afterwards *a* would arrive at Plymouth; thus:—12 hours' delay and 11 hours' steaming, enemy taking 10 hours; but he would be inferior to *c* and *d* together. He would know, however, that *b* would reinforce him in $9\frac{1}{2}$ hours, thus:—12 hours' delay, $8\frac{1}{2}$ hours to Portsmouth, and 12 hours to Plymouth, total $32\frac{1}{2}$ hours' steaming, as against *a*'s 23 hours. Until reinforced *a* would keep touch with enemy and of his own coast stations. In $22\frac{1}{2}$ hours, therefore, *c* and *d* would have to fight an action against superior force if he remained on the spot. If he retired *a* would pursue, leaving directions to *b* to follow. The coast stations and cruisers, and the Plymouth torpedo-boats, would easily enable him to do so.

Now consider an attempt on or near Portsmouth. It would take *d* $7\frac{1}{2}$ hours, steaming at 12 knots, to get there; *b*, allowing the 12 hours' delay as before, would arrive in $20\frac{1}{2}$ hours, or 13 hours later (at 11 knots). It would take *c* 19 hours to get to Portsmouth. R

[1] I have supposed them to be 1 knot faster than our ships, although such should not be the case.

must hear of *c*'s departure, but not his *force* (by cruiser despatched by A to Plymouth, thence by telegram), in 8 hours after he has broken out. If R left immediately for Portsmouth he would (at 11 knots) arrive there 19 hours after *c*'s leaving Brest; in fact, at the same time as *c* would.

R would, as he proceeded westward, pick up all cruisers and torpedo-boats he could find, and spread in line across the Channel, so as to establish communication with B off Cherbourg.

In this case *d* would have 13 hours free from interruption; *c* would get no time free, as R would be in the vicinity of Portsmouth as soon as he.

R and *b* would then be in touch with *d*, whose retreat to the west ward would be cut off by *a*'s keeping up communication between A and Plymouth.

If an attempt was made midway between Portsmouth and Plymouth, or in that vicinity, then *d* would arrive in about 9 hours, *c* in 11 hours.

Calling in for news first at Portsmouth and Plymouth, *b* and *a* would arrive respectively in 29 hours and 26 hours. Here the enemy would get 18 hours free from interruption.

An attempt made by *d* in the vicinity of the Downs would be met by R; *b* would hold the Channel between Cherbourg and Portsmouth, to prevent *c* effecting a junction. Seven ships 10 miles apart, in touch with St. Catherine's signal station on one side and B on the other, would ensure this.

If *d* made the attempt midway between Portsmouth and the Downs, or in that vicinity, he would only have $5\frac{1}{2}$ hours free before R's arrival on the scene. If *c* escaped at the *same* time, he would be at Portsmouth in 18 hours; *b* would be at Portsmouth $2\frac{1}{2}$ hours after (namely, 12 hours' delay added to $8\frac{1}{2}$ hours, total $20\frac{1}{2}$ hours). In 23 hours *c* would have joined *d*, of which junction *b* would be informed $2\frac{1}{2}$ hours *after* his arrival at Portsmouth, if he had not already intercepted him.

If he then started he would join R in under 6 hours' time (or 6 hours after *c* and *d* had joined), in time, in fact, to prevent him being crushed by *c* and *d*, supposing them to be strong enough to do it. Suppose *c* escaped 15 hours before *d*, so that they might effect a junction without having to wait for one another midway between Portsmouth and the Downs.

At Portsmouth his escape, but not his exact force, would be known 8 hours after (by cruiser to Plymouth, thence by telegraph). All the coast stations and cruisers would also be warned. In 23 hours after *c*'s escape *a* would be off Plymouth. A junction would at that instant have been effected midway between the Downs and Portsmouth by *c* and *d*. R would be $5\frac{1}{2}$ hours from them, but he might be inferior. A cruiser from Portsmouth to B would take 6 hours. R could therefore be reinforced by *b* in $14\frac{1}{2}$ hours, thus, 6 hours added to $8\frac{1}{2}$ hours (the time *b* would take crossing). R would be left in touch of a (perhaps) superior fleet for 9 hours.

It must be distinctly understood that I do not claim for these dis-

positions that they are the best possible. Neither do I wish to insist that the Downs would be the best strategical position for R.

The cases taken embrace most of the possible attempts on the south coast. My object has been to show that the longest time an enemy would get *free from interruption* between Portsmouth and Plymouth would be 13 hours, and the longest time free from a superior force 22½ hours.

The longest time he could get free between Portsmouth and the Downs would be 5½ hours, and the longest time free from a superior force 9 hours.

Appendix C.

Charge of Coast Defence Abroad.

In Germany the Navy have charge. Where they have not sufficient troops, the necessary numbers from the Army are placed under the orders of the naval Officer Commanding.

In France the Navy have charge of the defence of the naval ports. In other ports the Army provide the defence; the Officer in command of the naval force present is on the Staff of the General commanding the defences.

The Navy control the coast defence in Italy.

In Austria the direction of the coast defence is under the Ministry for War, of which the Navy is a section. The defence of the coast line is under the direction of the Commander of that army corps to which the coast belongs.

Pola is commanded by a naval Officer under the Commander of the army corps. The batteries are partially manned by the Navy; the mine defence is entirely in their hands. At other points naval or military Officers command, according as sea or land interests most predominate.

In Spain the coast defence is undertaken by the Navy.

In Russia the coast defence is undertaken chiefly by the Navy, except at such points where the defence of the land frontier is of greater importance.

The above information was obtained from a most valuable paper entitled "Coast Defence Systems" published in the Journal, Royal United Service Institution, vol. xxxii, No. 156.

Appendix D.

Summary of Conclusions.

(i.) Even if the main fleet sustain a defeat, the state of the enemy will not be such as to undertake an organized territorial attack in the face of Reserve or Flanking Fleet; consequently fortifications constructed to resist such an attack are unnecessary.

(ii.) Given an adequate naval defence, and proper organization of the land force as a *second line*, no enemy would risk attempting an invasion under cover of war-ships which had evaded our main fleets.

That, therefore, fortifications to meet such a contingency are superfluous, and should not be undertaken.

(iii.) To a great extent, ports are protected by those ships which it is necessary to provide for defending trade in their vicinity. That in consequence, if it is a question of providing ships or ports, and both cannot be provided, the former should be preferred.

(iv.) Fixed defences are desirable for the naval arsenals and great commercial ports at home, to hold them against a dash made by ironclads, which had succeeded in evading our blockade, until such time as we could depend upon overtaking them with superior naval force.

(v.) Similar defences are necessary for naval arsenals abroad. They should be on a much smaller scale than those in (iv), as not being open to attack from a heavy force despatched from Europe.

(vi.) Coaling stations and commercial ports abroad should be defended against one or two fast cruisers, which had succeeded in defeating the naval force keeping open the port. Allowance should be made for their having already fought an action.

(vii.) The cases of smaller commercial ports at home must be considered according to their relative importance; observing that an enemy's cruiser could blow in dock gates, and do much damage in half an hour.

(viii.) The defence of all naval bases and commercial ports should be under the control of the Naval Administration, and consequently the charges for them should be borne on the Navy Estimates.

Friday, March 4, 1892.

LIEUTENANT-GENERAL SIR ROBERT BIDDULPH, G.C.M.G., C.B., Director-General of Military Education, in the Chair.

THE EMPLOYMENT OF PHOTOGRAPHY IN RECONNAISSANCE.

By Lieutenant F. J. DAVIES, p.s.c., Grenadier Guards.

IT would be as well for me to begin by saying that it is not my intention to deliver a lecture on the science of photography, nor to attempt to teach my audience how to photograph. I intend to keep clear of theory as much as possible. I merely wish to bring to your notice some of the ways in which photography may be of use to soldiers.

Photography in the field has so far received official sanction that, I believe, it is proposed to attach a photographic equipment to the headquarters of an army in the field. I understand that two equipments have been prepared, one of which will be carried in panniers, on pack animals; the other in boxes, in a general service wagon. Both these equipments are very complete, and include large supplies of chemicals and other requisites.

I hope in the course of my remarks to be able to show that photography is a science of which soldiers can make very great use in time of peace, with a view to ultimate use in war, and further, that it is by no means impossible that it may be of service in time of war.

I shall endeavour, as far as possible, to avoid technical terms, and I shall not enter into the history of photography further than merely to mention the fact that it is the introduction of dry plates in the place of the old wet plates that has made this lecture possible, the salient advantages of the dry process being that we can take our plates into the field ready prepared, and that we can delay the development practically as long as we like.

I need not enter into the various improvements that have followed in the wake of the introduction of the dry plate process, I will only say that scarcely a week passes in which some mechanical or chemical improvement is not introduced; new and improved cameras, plates, films, paper, and developers succeed each other with astonishing rapidity.

I think that my lecture will be more intelligible to those who may not have practised photography if I describe very briefly and un-

scientifically the various operations which have to be gone through in order to produce a photograph.

First of all, we must have a camera with a lens; secondly, we must have a piece of glass, celluloid, or other suitable material which has been coated with some substance into the composition of which we need not inquire, but which is highly sensitive to light. When made of glass, this is called a "plate," when made of celluloid, a "film." This plate or film is placed in the camera in such a manner that, when the lens is uncovered, the light which passes through it falls on the plate or film.

To take a photograph, we permit the light to pass through the lens on to the plate for a longer or shorter period of time, according to circumstances; this is called exposing the plate. Exposure is of two kinds, "time," and "instantaneous."

The "image," that is the picture we are about to produce, has now been impressed on the sensitized substance with which the plate has been coated, but it is latent, invisible to the eye. To make this latent image visible we proceed to the second process, which is known as development.

Exposing the plate to a red light only, we pour upon it a solution, called a "developer," which causes the latent image to appear in the course of a few minutes. We next place the plate in another solution, which "fixes" the image, that is, makes it permanent. The plate can now be exposed to the light, and we have what is called a "negative;" it is an exact pictorial representation of what the plate saw through the lens, with the exception that everything is in reverse, what is black in nature is white in the negative, and *vice versâ*.

The next and last process is known as printing; this is effected by allowing light to pass through the negative on to a sheet of sensitized paper. There are a great number of different papers; in some the image appears gradually during exposure; in others, it must be developed by the use of chemicals. Some require a lengthened exposure to sunlight, with others the exposure is a matter of seconds only, and the light may be gas, lamp, candle, or even a match. We now have what is commonly known as a photograph.

There is a further development of printing, known as enlargement, by means of which pictures can be produced larger than the original negative.

I propose first of all to discuss the use of photography in illustrating sketches and reports; I shall then describe briefly how photography has been used, both in France and in the United States, for the production of accurate surveys, and in conclusion I shall mention two other uses to which photography can be put for military purposes, namely, the reproduction of maps, and the reduction of despatches with a view to their transmission by means of pigeons, or concealing them on the body or in the clothing of a disguised messenger.

I should like first to point out that the word reconnaissance does not, as far as my meaning goes, necessarily involve active service; on the contrary, we must remember that in peace-time also a very

large number of reconnaissances are executed, which are more deliberate, and consequently more valuable than those which are executed in time of war.

It is, I believe, laid down in all instructions for reconnaissance, that sketches should always, if possible, be illustrated by drawings in pencil, or pen and ink, and I think it is generally agreed that, particularly in road sketches, these drawings would be of the greatest value in enabling a person using the map to recognize important objects, such as church towers, buildings, cross roads, &c., as such drawings, *if well done*, will convey more to the mind than any map can possibly do. But notice, I say *if well done*. How many of us are there who can draw well enough for this?

It may, perhaps, at first sight appear that the importance of such illustrations attached to sketches has been exaggerated, but I do not think this is the case; I think they might be of the greatest possible value. The fact of an illustration being attached to a sketch or report may just prevent a column losing its way, by enabling the Officer charged with its direction to recognize his whereabouts.

I do not think we can overrate the importance of ensuring that everyone shall be able to find his way. The most masterly combinations of war may be marred by one man taking the wrong road; and a man may very easily do this in a strange country, with indifferent maps and ill-defined roads.

Now I have no wish whatever to disparage the art of landscape drawing, but I should like to point out some of the advantages that would accrue if photography were used for illustrating sketches and reports.

First of all, a very great number of us can never learn to draw, while I say most distinctly that we can all learn to photograph. I do not mean to say that we can all learn to produce works of art, such as I saw at Chatham the other day, but I do say that we can all learn in a very short time to photograph sufficiently well for the purpose we are discussing.

Again, the accuracy of a photograph is very much more certain than the accuracy of a drawing; even those of us who have an artistic talent are very apt to produce pretty pictures, which do not always bear much resemblance to the original.

Again, the time occupied in the field in taking a photograph can usually be measured by seconds, whereas to sketch a landscape entails a halt of some minutes.

Remember also that the plate can be exposed by one man, and developed and printed from by another: the slides containing the plates are always numbered, so that the person who exposes the plates has only to note down the number of the slide he used for each exposure: thus the plates can be sent back to be developed at headquarters, or, while the reconnoitrer is writing out his report, another person can develop and print.

In time of peace, the plates can, if more convenient, be sent or taken back to England for development. When visiting some of the battle-fields in Germany last year, I exposed forty-nine

plates, all of which I brought home, and developed at the Staff College.

Further, when once a photograph has been taken we have the power of reproducing it to any extent, each copy being an absolutely accurate reproduction of the original; this is not the case with drawings.

The man who develops need not have been present when the exposures were made; it is advantageous, but not indispensable, that he should know the exposure given, the stop used, and the amount of light (this information can be easily supplied to him).

As he takes each plate from its slide he marks on it, in pencil, the number of the slide. The photographs can thus be identified.

On the other hand, it must be allowed that photography has certain disadvantages. Chemicals may run short, some officious person may open the dark slide, "just to have a look," and thereby irremediably fog the plate: if glass plates are used they may be broken in transit, or the plates and paper may become injured by the weather, or they may be chemically imperfect; a difficulty may be experienced in finding a place wherein to develop: and a photograph is useless until it has been developed, and a certain amount of time may elapse before that can be done.

But I would point out, that in case of failure from any of these causes, you would be no worse off than if you had not tried to take any photographs at all, for the time spent in the field is not appreciable.

Let us first consider the use of photography for this purpose in peace-time.

As we all know, every great Power has established in some form or other an organization analogous to our Intelligence Department, for the purpose of collecting and compiling information concerning foreign countries, and which is therefore in constant receipt of reports from agents abroad. These reports are the result of reconnaissances executed in time of peace.

I think that consideration will show that in such reconnaissances great use can be made of photography; opportunities will often occur for using larger cameras than can be used when weights have to be kept down, or if only a small camera is used, enlargements may afterwards be made; by means of photography it will often be possible to give a far better idea of the nature and appearance of a country than a written report can possibly give.

Photographs could be taken of important road junctions, easily recognizable points along a route, such as peculiar rocks, trees, &c., entrances to mountain passes, difficult places, also points where rivers are fordable, a dotted line on the print would show the position of the ford, and the route to be followed in crossing the river.

The negatives could be stored, and, in the event of operations taking place in the country, copies could very quickly be printed for distribution. Enlargememts could be made when advisable.

The position and appearance of forts can often be admirably shown by means of photographs; enlargements will often bring out a surprising amount of detail.

I cannot, however, recommend photographing forts abroad as a pastime, as it is a practice to which the foreign police have a most rooted objection.

I may mention that I read in the papers a few days ago that two Russian Officers, who have recently ridden from Russia to India, were reported to have taken a large number of photographs during their journey.

I will not dwell upon the apparatus to be used for photographing in peace-time, as the circumstances under which the work is carried on necessarily vary very much. Sometimes large cameras will be used; at other times only the smallest possible amount of gear will be carried.

I will now refer to what I shall call rapid work; where the plates would be developed, and prints taken as quickly as possible, and handed in with the report or sketch the same day.

For this kind of work portability and simplicity of apparatus are the first desiderata.

Let me again point out that we do not want to produce pretty pictures, we merely want to record the appearance of an object so that it shall be easily recognizable from the photograph.

We may utterly disregard such things as yellow stains, hardness, and other troubles so familiar to photographers.

No time need therefore be lost in selecting pretty pieces, nor in "composing" the picture, though of course care is necessary in selecting the view to be photographed.

An exposure can often be made without dismounting, but this requires care, as sometimes the result is a view of the horse's ears. With fast plates the light will not often necessitate a time exposure; even in winter what is commonly called a snap shot is sufficient. I have some photographs here illustrating a road sketch, which were taken on February 17th, on a cloudy day, with no sunshine; but of course this would not have been possible late in the afternoon.

Now as regards the "outfit" for rapid work. As I said before, everything must be extremely simple and portable.

The camera should be of such a size as to be easily carried in the pocket or attached to the saddle; it should be light, and should be strong enough to stand the rough usage of a campaign. The shutter, that is the mechanism for rapidly uncovering the lens, should be inseparably attached to the camera; a "view finder" is indispensable, and it should also be part and parcel of the camera.

It should also be possible to give time as well as instantaneous exposures, and for this purpose the camera should be capable of being placed on legs.

There are now a great number of hand cameras in the market. I have a few specimens here to show the sort of hand cameras that are now being sold; there were notices of 80 in "The Photography Annual," last year.

Another matter is the question of "dark slides," as they are called, that is holders for the plates or films. I have here a variety of plate and film holders.

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I shall not enter into the question of lenses, as I think it is rather too scientific a subject for me to touch on to-day. I will only say that the stops should be rotatory, or an "Iris" diaphragm should be used.

As regards plates and films, it is of the greatest importance that these should be specially manufactured to stand extremes of heat and cold. Films have a very great advantage over plates, on account of their extreme lightness and portability.

For development we must have a concentrated developer, one that can be used several times over, and one that will develop prints. Here are some developers of this description that are now in the market.

Very few dishes must be taken; two, I think, would be sufficient, one for developing and one for fixing.

As regards paper, for rapid work I know of nothing like bromide paper. It has two great advantages:—

1. It can be used while the negative is still wet, and when thus used, no printing frame is required.

2. The light used is artificial; therefore, printing can be carried on at night.

The prints would be developed and fixed with the same chemicals that are used for the negatives, the only extra chemical required being the acetic acid for clearing; glacial acetic acid should be carried, as this is very concentrated. Bromide paper requires no toning.

I now come to the question as to how and where the operations of development and printing are to be carried on.

As I said before, the substance, or "emulsion," as it is called, with which the plate or film is coated, is extremely sensitive to light, so sensitive that its exposure to what we call a white light for one-thousandth part of a second will affect it; it is, however, not sensitive to red light: were it not for this, I fancy photography would be impossible. In developing the plate we must, therefore, work by a red light until the operation is completed.

There are several methods by which this can be accomplished. One is to have a "tent," or bag, into which the operator puts his head and arms, and is then tied up, the light being admitted by a red glass window; most of these "tents" are, however, comparatively bulky, and the heat inside them is sometimes insufferable, even in this country; they have this advantage, that development can be carried on anywhere, and in any light; they would also be extremely useful for changing plates.

Another way is to exclude all the light from a room, or tent, if living under canvas, or to wait till night, and work by a lamp with a red glass or shade.

Some form of folding lamp, burning a candle, is what is required. This would be the method employed in Europe, where the reconnoitring Officer could always depend on finding a house with a cellar, and would find a proper dark room in every town; in uncivilized countries, however, this could not be done, and the question is one of considerable difficulty.

The last piece of apparatus I will mention is a bucket full of water.

Where rapidity is essential, negatives can be developed and prints taken off in a very short time. The negatives are only washed for a few minutes, the wet paper is then pressed on to the plate and exposed to the light of a candle or lamp; the prints need only be washed for three or four minutes, this will prevent them losing their colour for several days; a washing of two hours makes them permanent; if the negatives are to be kept for future use, they should be subjected to the usual washing, after the prints that are required immediately have been taken off.[1]

A distinguished Officer in my own regiment, Colonel Colvile, C.B., who is unfortunately unable to be present to-day, has sent me some notes on the subject of outfit, which I should like to read to you.

I may add that Colonel Colvile has devoted a great deal of careful study to the subject. He writes as follows:—

"I consider that the camera should be ¼-plate, or lantern-slide size, and be made of aluminium. In order to insure perfectly sharp pictures for enlarging, the picture should be capable of being carefully focussed; but in the ordinary camera this is incompatible with quick hand work; the camera should be double, or should have a movable reflector.

"The *lens* should be a 'rapid rectilinear' of about 4-inch focus.

"*The dark slides* should be specially constructed to carry films without the intervention of carriers, and, in my opinion, should be made of cardboard.

"Roll holders are sometimes convenient, but they are more trouble to refill than dark slides, and they are both wasteful and inconvenient if negatives have to be developed as soon as they are taken.

"No really satisfactory shutter has yet been invented, but I believe that the Loman blind shutter (sold by Mawson and Swan) is the best in the market for the purpose under consideration.

"*Field Developing Outfit.*—This should be light, simple, not easily damaged by climate, and arranged so as to work with the least possible amount of discomfort in hot weather, and so as to enable development to be carried on in the brightest sunshine.

"From the fact of their being almost insupportable in the tropics, and ceasing to be light-tight after a little wear and tear, I do not consider any of the developing bags or "tents" at present in the market to be suitable, while from their bulk, developing boxes are equally unsuitable. As cold weather is usually accompanied by long nights, giving ample opportunities for development without special arrangements, it is only necessary to consider a hot-weather outfit.

"*Printing.*—A ¼-plate paper print is almost useless for showing the detail of a country, but a glass, or celluloid transparency, viewed though a magnifying glass, or cast on a screen, will bear a great amount of enlargement, and consequent amplification of detail. I am, therefore, in favour of reproducing all negatives developed in the field on lantern-slide plates or films. For this purpose no addition

[1] During the lecture two previously exposed plates were developed in the cellar of the Institution, and a print taken from each; these operations were completed in *sixteen minutes*.—F. J. D.

need be made to the developing outfit beyond one ¼-plate printing frame.

"*Enlarging.*—Owing to the size of the dishes used and the amount of space required to be kept in darkness, I think enlarging in the field is hardly practicable for an Officer unprovided with special accommodation. In civilized countries it would doubtless be most advantageous if a travelling dark room, in charge of a sapper, were attached to the headquarter office. The photographic results of a reconnaissance could be handed in as soon as taken, and could be reproduced in a few hours, in an enlarged form, for the inspection of the General Officer Commanding. In our small wars, however, this would be impracticable, and in such cases I suggest that the lantern slide I have recommended should be thrown on a piece of paper, say, 20″ × 30″, by means of the camera with which the original negative was taken and a small magnesium lamp; this is rather an expensive method of showing lantern pictures, but its convenience makes it by far the most suitable."[1]

Balloon Photography.

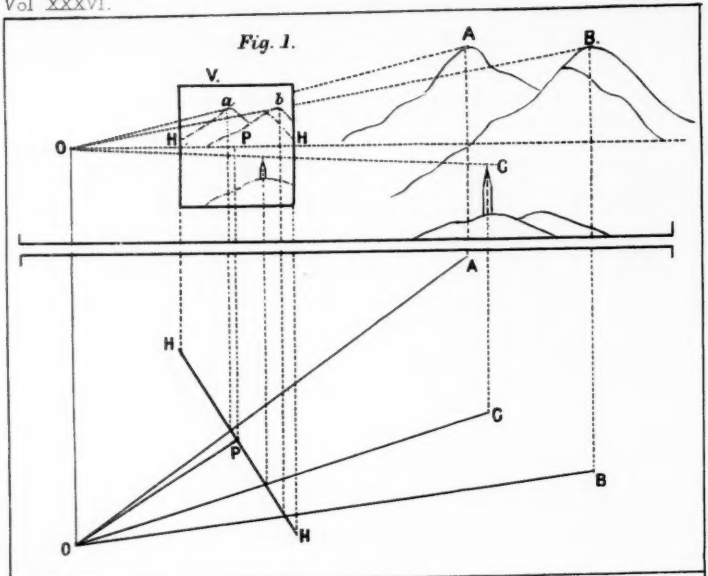
The use of balloons in war affords another opportunity for using photography in reconnaissance. Several attempts have been made from time to time to develop balloon photography, and special cameras have been devised for this purpose.

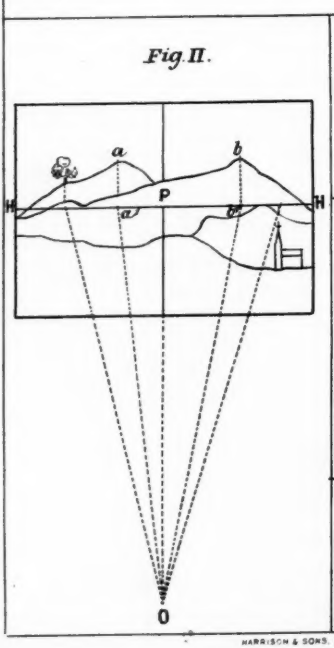
It has been proposed that balloon photography should be used in sieges by the besiegers. One plan is to start a small balloon, loaded with a camera, but without an aeronaut, to windward of the fortress, the plates being exposed by means of a clockwork arrangement, or a slow match, the time which would elapse before the balloon will reach the point or points where the exposures are to be made being estimated beforehand. As the gas gradually escapes, the balloon descends on the further side of the fortress within the besiegers' lines.

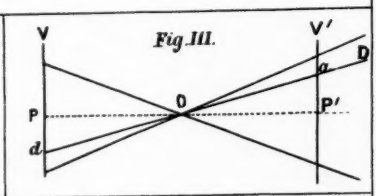
Lieutenant Reed gives an instance of the practical use of balloon photography in war.

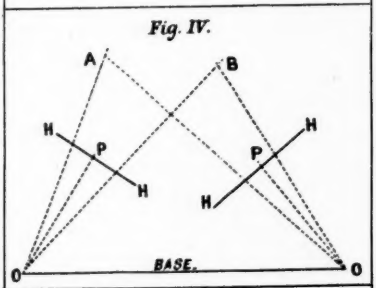
While besieging Richmond the Federals employed a balloon to reconnoitre the enemy's positions. From this balloon a photograph was taken on a single plate of all the country between Richmond and Manchester, on the west, and the Chickahominy on the east; the rivers, smaller streams, railroads, marshes, pine woods, &c., were all represented, as well as the dispositions of the troops. Two prints were made, one of which was retained by the Army Commander, and the other by the aeronaut; rectangles were ruled on the prints, the same on each, reference letters being attached, and since in subsequent events telegraphic communication was established between the balloon and headquarters, the aeronaut was able to give information of any important events that occurred in any rectangle, which information in several instances proved of great value.

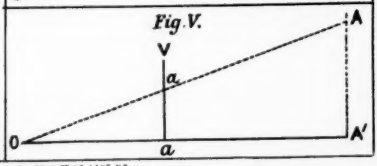
[1] Colonel Colvile is bringing out a campaigning camera and a dark slide, both of which were exhibited and explained to the audience.—F. J. D.











HARRISON & SONS, LITH. ST MARTINS LANE, W.C.

Surveying by Photography.

I will now briefly describe how photography has been used as a means for obtaining the data for the execution of an accurate survey.

For the greater part of my information on this subject I am indebted to Lieutenant Henry A. Reed, U.S. Army, who has kindly allowed me to make full use of his work on the subject, called "Photography Applied to Surveying." The method is by no means new. As much as thirty years ago, Colonel Laussedat and Captain Javary, of the French Army, made surveys near Paris and Grenoble on the principle I am about to explain. I may mention that, as regards accuracy, one of these agreed exactly with the Government survey, while in the other the differences of level as compared with the regular survey nowhere exceeded 19 inches.

The method relies upon the application of the principles of plane perspective.

If we wish to obtain the view of an object in perspective, we start from two projections as data, viz.: the vertical projection and the horizontal projection. In applying the method I am about to describe we work back from the perspective view, *i.e.*, the photograph, to the two above-mentioned projections.

It would be as well to define certain terms used in perspective.

In Fig. 1 the picture V represents the distant typographical features as shown: the hills A and B, and the church C, being shown in perspective. O is the eye of the observer or "station point;" P is the point in which a visual ray, perpendicular to V, pierces it, and is called the "point of sight;" the line HH is the "horizon of the picture;" it is the intersection with V of the observer's horizon; the points where straight lines joining the distant objects with O pierce V are the perspective of those points.[1]

Now, if the different points of a landscape and the visual rays intersecting them be vertically projected into the plane of the horizon, the angles included by the projections are the true horizontal angles, the same as would be measured by a theodolite.

Since the positions of HH and P, and the distance OP, are always known, it follows that if V be laid on a flat surface (see Fig. 2), and PO be set off perpendicular to HH, and a and b be vertically projected into HH, at a' and b', then the horizontal angle between a and b will be included by the straight lines joining these projections with O; in other words, the angle $a'Ob'$ will be the angle subtended at the observer's eye by the two hills A and B.

I will now explain how these principles apply directly to photographs. In Fig. 3 V and V' represent respectively the position of a photograph and a perspective drawing with regard to the "station point;" as regards V', the point O represents the observer's eye; as regards V, the photograph, O represents the "optical centre," which is the point where the rays cross.

[1] These are the terms used in most English books on Perspective. Lieutenant Reed employs slightly different terms.—F. J. D.

V and V′ are vertical, parallel, equidistant from O, and the straight POP′ pierces each at its middle point, and since any point D is projected by the same visual ray at d and d', which are equidistant from the middle points of V and V′ respectively, it follows that the two views are similar.

I will now give an outline of the working of the method.

A base is chosen, measured, and its magnetic bearing observed, as in ordinary surveying: from each end of the base a series of photographs of the ground to be surveyed are taken; for each exposure the camera must be carefully levelled, and the magnetic bearing of the axis of the lens observed and recorded. By a mechanical arrangement in the camera the horizon line, and a vertical line representing the vertical plane containing the axis of the lens, are marked on the negative, and consequently appear on the print; the point where these two lines cross is what is called in perspective the "point of sight," P (Fig. 2).

The "focal length" of a lens can always be ascertained; this is the equivalent of the distance OP.

Let us take a simple case as an example: suppose that we have taken one photograph from each end of the base, and that on each there is a representation of two hill tops, the position of which we wish to fix in plan. As we know the length and bearing of the base, it is clear that to fix these points we have only to ascertain their bearing from each end of the base.

We next proceed as follows: on each photograph we draw perpendiculars from the representations of the two hill tops to the horizon line (Fig. 2). We then plot the base on the paper in the usual manner (Fig. 4), and from each end of the base we draw a line, having the bearing recorded in each instance as the bearing of the axis of the lens, making each of these lines equal in length to the "focal length" of the lens; at the ends of these lines furthest from the base, draw lines at right angles, to represent the horizon lines; the ends of the base will be the "station points," and the points where the lines from the end of the base meet the horizon lines will be the "points of sight."

We now measure on the photograph the distance from P (Fig. 2) to the points a' and b', where the several perpendiculars from the objects fall on the horizon line, and mark off similar distances from the "principal point" on the horizon line on the paper; if we join the end of the base with the points so marked on the horizon lines, we shall be drawing the bearing of the objects from each end of the base, and shall thus be able to fix their relative positions by intersection.

Having fixed the positions of A and B in plan, we must ascertain their height with regard to the datum level, viz., the observer's horizon.

In Fig. 5 OA′ is the distance from the point at which the view was taken to the object; Oa' and $a'a$ are the distances from O to a' and a to a' (see Fig. 2). AA′ will be equal to the height of A above the observer's horizon; it is clear that the triangles O$a'a$ and OA′A are

similar triangles; therefore, as we know the lengths of Oa' and aa and of OA', we can find the length of AA' by trigonometry, arithmetic, or construction: for instance, we wish to find the height of A above the observer's horizon. We measure Oa' and aa' on the print (Fig. 2), and find them to be 10 inches and $\frac{1}{2}$ inch respectively; measuring on the plot, we find A to be 600 yards from O; to ascertain the value of AA' we have a simple proportion sum—

$$10 \text{ inches} : 600 \text{ yards} :: \tfrac{1}{2} \text{ inch} : x;$$
$$\therefore x = \frac{600}{10 \times 2},$$
$$= 30 \text{ yards},$$
$$= 90 \text{ feet}.$$

The above description is merely an outline of the way in which the survey is carried out.

As regards rapidity of execution, Lieutenant Reed states that M. Javary, a French Engineer Officer, once made, in six hours, a complete photographic survey of a zone three-quarters of a mile in width in front of a fortified place; and, after eight hours expended in plotting, presented the Commanding Officer of the attacking force with an exact and complete map, including the levelling; this in rainy weather, and with the old-fashioned wet plates.

A writer in the "Entrétiens Militaires de la Réunion des Officiers," in 1872, states that with four trained operators a plan can be made of any fortress, except Paris, in 24 hours.

Lieutenant Reed claims the following advantages for photographic surveying: an entire tour of the horizon, or any desired part thereof, is obtained in a few minutes by a series of very simple operations, involving no multiplied nor fatiguing observations, no drawing sketches or lines of direction difficult to trace in the field, no delicate pointings nor minute readings, and no prolonged observations. There is no fear of having forgotten or omitted some important point, because every visible detail is represented; the office work presents no difficulties; all the work done in the field is of value; and, the map finished, the photographs as addenda present a view as comprehensive as if the observer had personally traversed and inspected the tract surveyed.

I understand that whenever this system has been tried in England it has proved a failure; still I cannot but think that it might be of use in open countries, particularly in siege warfare. It would also seem that photographs would be valuable additions to the range tables, as facilitating the identification of the points named in the tables.

Reproducing Maps.

As regards the copying of maps, I shall not enter into details. I will only point out that if it is necessary to reproduce a few copies of a sketch at short notice these can be easily obtained by photography. The original sketch is photographed, and prints taken off in the usual

manner; if, as will often happen, the exposure has to be made at night, magnesium wire will replace the light of the sun; such work would, I imagine, be handed over to the R.E. photographic detachment.

Reduction of Despatches.

A short account of the use made of photography in the reduction of despatches for transmission by pigeon during the war of 1870—71 may be interesting.

My information is derived from "La Pigeon Messager," by La Perre de Roo; "Les Télégraphes et les Postes pendant la Guerre de 1870," by M. Steenackers, who was at the time at the head of the French Post Office; and from a lecture delivered at the Camera Club, three years ago, by Captain Mantell, R.E.

A regular service of pigeons was established between Tours, which was the seat of the Government of the National Defence, and the capital, and afterwards from Bordeaux. The weight which a pigeon can carry is of course very small, if therefore the despatch were written, or even printed, very little information could be sent by one pigeon; recourse was therefore had to photography, in order to reduce the size of the despatches.

The despatches were first printed on a sheet of paper containing about 300,000 letters; this was reduced to a negative about $\frac{1}{3\,0\,0}$th of the original, and then printed on a film of collodion. About twenty such films could be carried in a quill by one pigeon, containing, according to Captain Mantell's estimate, some two or three million letters, or the equivalent of sixty ordinary newspapers, the whole weighing only 15 grains.

On arriving in Paris, enlargements were made by means of the photo-electric microscope.

This last part of my lecture is rather outside my subject; I have mentioned it as a matter of general interest, and as another instance of the use of photography.

In conclusion, ladies and gentlemen, let me say that I do not wish you to picture to yourselves an advancing army preceded by a cloud of Staff Officers armed with "Kodaks," like a lot of tourists; my object has been to bring military photography to your notice, with a view to raising a discussion on its merits and possibilities. I think that it has a future, and that it is worth our while considering, how far it may be of use in helping us to attain that great object of all military movements, namely, to get to the right place at the right time.

Lieut.-Colonel EVERETT (Professor of Military Topography, Staff College): I hardly think I am the proper person to commence a discussion on the very interesting lecture that has been given us, because I hold so strongly the views of the lecturer on the subject. Under these circumstances, I should have rather preferred to reply to someone who might have taken the opposite view. Perhaps, though, that would be difficult, because I feel almost certain that everyone here who has listened to the lecturer must agree with the views that he has expressed, or, at all events, with most of them. I think the main

question involved in his lecture is, whether photography could be made use of by Staff Officers reconnoitring in the field, or, in other words, whether photography would not be better than landscape drawings executed with pen or pencil? That question can hardly be answered until we have replied to another, viz., Are illustrations of any kind useful in reconnaissance? There are some men who hold the opposite view. For myself, I believe them to be most useful accessories—I mean ordinary sketches—and, indeed, I do not consider a reconnaissance to be complete unless sketches are sent in with them. The very best report fails to convey to the mind an accurate impression of the nature of the ground described, and any impression is only gained after a great deal of trouble; whereas a single glance at a good sketch makes the whole thing perfectly clear to the Officer for whose benefit the work has been done. Therefore I think we may say that sketches *are* certainly most useful. And now comes in the question: "Are photographs better than sketches?" I have had some experience in the work. I have been employed on long reconnaissances, lasting sometimes for weeks, and even for months, and I may say from that experience that, in the first place, the preparation of landscape drawings is often very tiring work, and, sometimes, very cold work. You may see something most interesting that you want to draw. You may have been working all day: you feel a bit tired, and, perhaps, cold too; you do not care to sit down; you pass on, and the subject is gone for ever. But if you have your camera the work is done in a moment, and you ride away, rejoicing. Now, I think that is a very great advantage. Mr. Davies has said that all of us cannot learn to draw. I think a good many here will say he is perfectly right; but I will go further. From the experience which I have had at the Staff College, I have come to the conclusion that photographs are better than the best sketches that can be made; and I have come to that conclusion by comparing them with the photographs. Let us take a bridge for example. You want the details of that bridge; you want to know all about it. It may have to be destroyed, and you want to know how to do it. Well, take a sketch: take a number of sketches: none of them are alike, and none of them give an accurate representation of the bridge; and the worst of it is that, the better the artist, the greater is the dissemblance. Well, gentlemen, we are all like that; we like to idealize a little bit if we can use the brush or pencil. But with the photograph we have a check on us, we cannot do anything of the sort, and therefore the photograph gives us invariably—what the sketch does not—the truth. I should like to say one word as to what Lieutenant Davies has told us with respect to the ease of it all. That the actual operation of taking the photograph is easy you can clearly see. As regards the development at night, there is an album on that table with some photographs which I have taken myself, and I may tell you that most of them were developed in tents, very often with very indifferent water. Some have been developed under moonlight. True, the tent had a dark-blue lining, but still I could see the moon through it; yet there was no danger to the photograph, *i.e.*, the negatives were not fogged: therefore, you will observe, that development can be done in a tent, and I think that this is an important fact. As regards rapidity of development and printing, I may mention that at the Staff College, a year or two ago, we had a distinguished photographer. He was working with Eastman bromide paper, a paper you can print with by candle-light very rapidly. He was timed, and he developed and printed six bromide prints in *half an hour*. I think that fact is very valuable, from a military point of view also. As regards the feasibility of development in wartime, possibly it might not always be feasible, but it would not be reasonable to condemn a process because now and again it could not be conducted. I say it might not always be feasible, but it might very often. On the whole, therefore, gentlemen, I am inclined to think that photography is, indeed, a valuable—most valuable—adjunct in reconnaissance work, and that perhaps it has been neglected almost too long. At the Staff College I am glad to tell you that we have got a number of photographers, of whom Lieutenant Davies was, till lately, one of our most distinguished; in fact, out of the sixty-five men now at the college, we have twenty-six who are either photographers or on the way to become so. Not only for reconnaissance, but in many other ways, as the lecturer has informed us, photography is of use; and, indeed, I am inclined to think that even for describing

the position of troops in action, and the formation employed at certain periods, photography would come in and assist in setting at rest many vexed questions which are often discussed after a campaign, and never satisfactorily settled. I may tell you I have seen a photograph by a man of a bear which he shot a few seconds afterwards; and I think it illustrates what may be done in moments of extreme excitement with a camera and a little coolness. I must apologize for having taken up so much time, but my feelings on the subject are, as I mentioned at the outset, strong, and I fear I may have let them run away with me.

General Sir C. P. Beauchamp Walker, K.C.B.: I entirely concur as to the very interesting lecture we have had. I know the very large extent to which photography was made use of by the French during the siege of Paris, because all the letters that were sent out by balloons were photographed, and of course the number of letters carried by balloon was something enormous. As Mr. Davies has already said, we shall very probably have a very considerable illustration of this from Mr. Tegetmeier, who is going to give us a lecture on pigeons. I have no doubt he will mention the capacity of pigeons, as has been detailed by Mr. Davies. I very much admire the lecture.

Captain Leith Tomkins: Perhaps the lecturer will kindly give us some of the difficulties. He has given us an account of the successful results which we have been very pleased to hear; but I think if he would tell us some of the difficulties he has met with, and how he has got over them, it would be of great interest. With regard to apparatus, choice of camera, and so on, no doubt he has tried several before he finally decided which would suit his purpose best.

Lieutenant Davies: I thank you very much for the kind way in which my lecture has been received, especially for the kind way in which Colonel Everett has spoken on the subject. With regard to difficulties, I may say that I have here on the table the result of every plate I ever exposed in photography on reconnaissance. They may all be seen, and I do not think I ever had a failure in any of them. I had a few failures abroad because some of the boxes in which they were packed were not strong enough; they came to pieces. The weather was the worst I had ever seen in my life. We had nothing but blizzards all day long. Here is a specimen of a photograph taken in a blinding snow storm. Everybody thought it was perfectly absurd my exposing a plate. I had nine failures in all out of forty-nine, principally owing to the box having been broken and light having got in. As regards cameras, I cannot say I have tried a great number. I have only used one kind for this particular work, and that is a camera made by Messrs. Shew, called the "Eclipse" camera. I cannot profess to have here specimens of every kind of camera, but I have brought a few to show you how portable the apparatus now is.

The Chairman (Sir Robert Biddulph): Gentlemen, I think we may very fairly judge from the total absence of hostile comment of any sort or kind on the lecture, that the meeting is entirely unanimous in agreeing with the lecturer and with what Colonel Everett has said as to the value of photography in connection with reconnaissance. In fact, I think it is a matter which admits of no dispute. Anyone who has had any experience of looking at either sketches or landscape drawing will agree that the accuracy and clearness of photographs renders them a great aid in appreciating the actual lie of the country on the situation. I agree especially with what Colonel Everett said as to the importance of getting accurate details. I am quite certain, as he said, that when you come to make a drawing of a building or bridge or anything of the sort, that there are many details necessarily omitted which the photograph represents, either immediately visible or which are made visible by magnifying. The advantage of using photography in peace-time, as alluded to by the lecturer, cannot be overrated, and I am sure that in the case of gentlemen travelling in distant countries, more especially those countries which might become the theatre of war, such as those on the outskirts of India, which are liable at any time to become the theatre of active operations for our troops, it would be of the very greatest advantage to have exact representations of the different places which they visit, and these may very often be found, in the most unexpected way, to be most valuable. As regards active operations, it seems to me that there is one special occasion which has been already alluded to, in which

it is most valuable, that is in the conduct of a siege. I cannot imagine, in modern days, anything more valuable than being able, say from a captive balloon, to take exact photographs of those parts of the positions of the besieged which are not otherwise visible, and the ability also to observe the effect of the fire of the batteries. The science of the besieger's fire has advanced to limits beyond anything of which we had any idea in the days of the siege of Sebastopol. I am alluding to the siege of Strasburg in 1870, where breaches were made from invisible batteries. In that case those working the batteries could have had no means of judging of the effect of their fire. They could very well have judged that effect from the view taken from a captive balloon; and, of course, if it were photographed and brought down accurately to the General Officer in command, he could rectify any defect which had been made in the firing. I merely mention that as an illustration. The use of photography in the field is a matter of quite modern practice; but there is one example alluded to by the lecturer which I think perhaps Sir Beauchamp Walker will remember, in which it was of very great value in the old days, and that was in the China War of 1860. We had the very greatest difficulty in knowing what was the actual state of Pekin. No map was in our possession. The Russian Legation had secretly prepared a map a few months before, which they had done in a very expert way to avoid the jealousy of the Chinese. They had sent an Officer in a small covered cart, such as they use to carry their women about, completely covered in. An indicator was attached to the wheel. He drove for a certain distance, to a certain cross-road we will say, and then he took a shot with his instrument: then down the next road, and travelled along that, and in that way he made a complete plan of the City of Pekin, with all its streets and roads, both in the Tartar city and the Chinese city. They were anxious to show their good will to us, and General Ignatieff, who produced this map, offered its use to the English. We had no photographers in the Royal Engineers then, or attached to the Army; but there was an Italian gentleman who had followed the Army for his own private purposes with a view of producing photographs to sell to the public, and he was set to work to reproduce this map. He produced a sufficient number of copies for our requirements, and they were extremely serviceable. Had it been necessary to storm the place, that map would have been extremely useful for the purpose of rescuing the prisoners who were known to be in a certain place in the city; so that, if it had been necessary to storm Pekin, a party would have been immediately detached to rescue the prisoners before any harm came to them. That is the only illustration I can give you of anything of which I have any personal knowledge. As regards the reduction of despatches, the lecturer did not tell us, what, I think, is a most interesting illustration of that. I remember well, in 1870, the French in Paris and their friends outside had very great difficulty in communicating, and it became a regular practice for persons who wished to communicate with their friends in Paris to have those communications printed on the first sheet of the "Times." I am sure some present will remember what an extraordinary appearance the first sheet of the "Times" used to present in those days, full of all sorts of private letters. They were afterwards photographed and reduced, and sent in under a pigeon's wing. When they arrived in Paris they were reproduced in large sheets and stuck up in public places, and everybody who expected a message from his friends went and studied this sheet to see if he could find it. That, I think, was a very interesting illustration of the reduction of despatches and their reproduction afterwards. And, of course, not only private despatches but public news also was conveyed in that way—news which the people inside Paris could not otherwise have got. I think, judging from your unanimity, I need not do any more than to ask you to allow me to convey your thanks to the lecturer for the very interesting manner in which he has brought this subject before us.

MODERN RIFLE BULLETS AND THEIR EFFECTS.

By Brigade Surgeon Lieutenant-Colonel C. H. Y. Godwin, Professor of Military Surgery, Army Medical School.

In a paper on "Magazine Rifles in War" published in the Journal of the Royal United Service Institution for the month of November last, the author writes: "We endeavour merely to disable our enemies individually and collectively, but the disabilities inflicted should, under the circumstances, be at least grave enough to prevent the injured from taking any further part in the campaign;" and the argument of the paper, if I rightly understand it, is that the bullet of the Magazine rifle has been so reduced in weight and size that, judging from the two cases reported, it will be inefficient to check men opposed to us in any future war, and also, if they are wounded, the nature of their wounds will be so slight as to scarcely render them ineffective for longer than a few weeks.

I propose to bring forward in reply a series of experiments that have been made in France with the Lebel rifle as against the Gras, as they are very comparable with the two military rifles at present in use in this country, namely, the Martini-Henry and the Lee-Metford or Magazine rifle.

	Bore.	Weight of bullet.	Muzzle velocity.	Rate of spiral.
Martini-Henry	0·450	410 grs.	1,362	1 in 22
Magazine	0·303	217 „	1,850	1 „ 10
Gras 11 mm. or	0·433	386 „	1,493	1 „ 22
Lebel 8 mm. or	0·315	231 „	2,000	1 „ 9·4

The Martini-Henry and the Gras bullet is a solid one of lead, hardened with tin and antimony respectively.

The Magazine bullet has a core of lead hardened by antimony encased in a cupro-nickel envelope.

The Lebel bullet has a core of lead encased in an envelope of maillechort.

The extracts quoted below are taken from a paper published in the "Archives de Médecine et de Pharmacie Militaires" for the month of February, 1891, and headed "A Study of the Comparative Effects produced by the Bullet of the Gras Rifle 11 mm. in diameter, and of the Lebel Rifle 8 mm. in diameter; by M. M. Delorme, Professor of Surgery, Val de Grace, and M. Chavasse, Assistant Professor of Surgery, Val de Grace."

Experiments with the Gras and Lebel Rifle in France.

In a paper read before the Academy on 29th May, 1888, the authors, after a series of experiments most carefully conducted, reviewed the lesions produced by the bullet of the Lebel rifle, and came to the conclusion that the type of fractures caused by this small-bored rifle 8 mm. (0·315 inch) were, with some slight differences, almost the same as those that had already been described as caused by the Gras rifle 11 mm. (0·43 inch). Since then a further series of experiments have been conducted, and the effects produced by the two bullets have been compared—

1st. By firing the bullets at equal ranges.

2nd. By firing the bullets so that they should possess the same velocity at the moment of impact, which of course was only possible at very dissimilar ranges, owing to their different initial velocities.

The authors state that a condition of the first importance with respect to the value of the results was to fire at exactly similar parts of the limbs and of the bones of one subject, and, notwithstanding all their previous experiments, they have only taken account in the present paper of the occasions where the conditions in each case were absolutely fulfilled; they add, it is not any exaggeration to say that the results obtained present a high degree of accuracy.

Impact.—The shock impressed by the force of the projectile on a fractured limb was always shown to be much more considerable with the leaden bullet of the Gras rifle 11 mm. than with that of the Lebel rifle 8 mm., whatever might have been the distance, the velocity, or the points of bone fractured. The difference, however, was infinitely less marked, almost absent, in fact, when the soft parts alone were traversed. This fact was especially remarkable in firing from such ranges as 400 metres, and at certain bones, as the humerus or femur. These long bones, when struck by a Lebel bullet 8 mm. at ranges such as 300 or 400 metres, did not seem to have received a sufficient shock to lead the surgeons to believe that there was a fracture, which was discoverable only after a direct and close examination; whereas, when the bullet was from the Gras rifle 11 mm. the fracture could always be recognized at once by the oscillation of the limb. This absence of shock in limbs struck by the Lebel bullet appeared to be due to the greater power of penetration, to its smaller diameter, and to its preserving its shape unaltered.

The authors conclude from these experiments that the general shock, as well as the local shock, will be less with these new enveloped projectiles, especially when fired at distances over 400 metres.

Explosive Effects.—The bullets of the Lebel rifle 8 mm., as also those of the Gras 11 mm., produced, at distances relatively short, effects on the tissues which have been termed *explosive*. Under ranges of 300 metres, especially at ranges of 200 metres, with the Lebel rifle explosive effects were observed in wounds of the skin and muscles; the muscular tracks were very large, sometimes enormous, whether the bones were fractured or not. Indeed, with both the Gras and the Lebel rifle bullets, when they met a long bone capable of offering

some resistance, the lesions were so much the more considerable according as the velocity was greater; in a word, the shock, the destruction of the soft parts, and the comminution of bone increase with the velocity. With the Lebel bullet these effects were obtained almost regularly up to ranges of 280 metres, and sometimes in ranges of 300 and 320 metres, when the bullets encountered a hard resisting bone. With the Gras rifle 11 mm. such injuries were not produced much beyond 100 or 150 metres.

Examples of the so-called explosive effects are illustrated by the following experiments:—

Experiment I.—Gunshot wound from a Lebel rifle at 280 metres. The bullet hollowed out deeply the middle part of the right tibia, near its internal border a little obliquely. The wound of entrance had a diameter of 10 mm.; the wound of exit looked like a longitudinal bursting open of the skin 11 *cm.* in length, through which the muscles protruded; the fracture was very comminuted.

The gunshot wound of the Gras rifle at the same range produced a large hollowing out of the middle part of the left tibia, in all respects comparable in type to the preceding one, with detached splinters from the posterior face of the bone; moreover, a single fissure of 0·13 mm. in breadth split the external face of the bone. The wound of exit of this bullet had only the dimensions of the index finger. The lesion was grave, but it did not present by any means the degree of attrition, the extensiveness, or the comminution of the preceding injury.

Experiment II.—Gunshot wound of the middle part of the right thigh by a Lebel bullet at 280 metres. Fracture very comminuted of the femur, wound of entrance measured the same in diameter as the bullet, wound of exit was as broad and as long as the hand. The Gras rifle bullet only made a wound of exit on the opposite limb of the size of the top of the thumb, at the same range. The seat of fracture was, like the preceding one, 8 cm. in extent, but it was a less clean one than the other, although the amount of splintering was about the same. Fissures in the ends of the bone extended up for 6 cm., but none were found in the right femur.

Experiment III.—In a third case, a gunshot wound of the middle part of the thigh due to a Lebel rifle bullet at a range of 320 metres, the following lesions were noted, which were very remarkable. At the side of the wound of entrance, which was clean and regular, and scarcely larger in diameter than the bullet, was a tear through the skin 0·12 metre in length, widely gaping, through which the mangled muscles could be seen. The vessels, apparently intact, but bruised, crossed the cavity. The wound of exit looked like a large square chasm 14 cm. in length, of tattered flesh held together in part by some filaments of the sciatic nerve. There was a clean fracture of the femur, with a loss of substance 9 cm. in length between the ends of the bone, which were not fissured. Such an injury as this had never been met with, the authors say, at such a range with the Gras rifle.

These kinds of injury explain what is meant by the explosive

effect of a solid bullet; it is just as if the wound had been made by an explosive bullet.

On the spongy and articular ends of the long bones, the destructive effects of the Lebel rifle at ranges of 200 and 280 metres were sensibly less than those of the Gras, but at closer ranges the effects of the two rifles were very similar and very severe.

To repeat, up to 100 metres, the two rifles produced occasionally the same kind of explosive effects. From 100 to 200 metres, the Lebel rifle continued to produce wounds of this kind when striking the shaft of a long bone, but at other ranges in the case of joints the Gras rifle was the more destructive.

From these experiments one fact is evident, that the severity of the injury is in direct proportion to the velocity of the projectile, and the amount of resistance it meets with. The Lebel rifle bullet presents a marked inferiority to the Gras rifle bullet, which is so easily altered in shape, when we consider its weight and the little tendency it has to become deformed.

At 1,600 metres, the Lebel bullet made a wound of entrance no larger than its own base, while at short ranges, both bullets made openings in the skin as large as the tip of the little finger. The wounds of exit in the case of both bullets when they had only passed through the soft parts presented no peculiarities.

Injuries to the Shafts (Diaphyses) of Long Bones.

The lesions produced on the shafts of the long bones by bullets possessing the velocity of the Lebel rifle for ranges up to 280 or 300 metres, and up to 100 or 150 metres for the Gras rifle, have been noticed under the heading of explosive effects.

At ranges from 300 *to* 800 *metres.*—The lesions of compact bone caused by either bullet were always most serious, but became less so as the range increased. The size of the splinters of bone increased, while the pulverization and scattering of the fragments of bone diminished, with the distance. The general characters, however, of the wounds caused by the two bullets were much alike, but with some differences.

The Lebel rifle bullet, on striking compact bone at these ranges, produced a pulverization, or a great shivering into pieces of the compact bone which were scattered with force in all directions. Of these particles of bone, some were free, and others remained adherent to periosteum; nothing like this was seen with the Gras rifle.

It often happened that fissures extending from the seat of fracture were less extended in the case of the Lebel bullet than in the case of the Gras. At these distances, however, the differences of action of the two bullets did not appear to be of great importance.

From 800 *to* 1,200 *metres.*—The Lebel bullet caused a less amount of comminution of bone than the Gras; there were fewer loose splinters of bone, and the extent of the fissuring was less; hence, the fractures of the Lebel bullet were, at this distance, less severe than those of the Gras.

Beyond 1,200 *metres.*—The Lebel rifle bullet appeared to produce more comminution of bone than the Gras; fractures of this kind were met with up to 1,500 and 1,800 metres.

Effects upon Joints (Epiphyses).

In the case of wounds of joints (epiphyses) beyond the range of 300 metres, the effects of the two bullets were very much of the same character, except that, owing to the difference in size and the maintenance of its proper shape, the Lebel bullet did not force so widely asunder the fragments of the articular ends of the bones.

Results obtained for the two Bullets with equal Velocities.

Some experiments were made with the two bullets when possessing the same velocities; to do this the range of the Gras rifle had to be lessened and that of the Lebel increased.

In these experiments the lesions produced by the Lebel rifle were less grave than those of the Gras; the general character of the types of fracture, however, varied but little.

In the case of the smaller and enveloped bullet there was a less-marked lateral displacement of the splinters attached to periosteum, and the loose, or nearly loose, splinters were not so forced into the surrounding muscular tissues. On the other hand, the Lebel bullet, with its great and mean velocities, was attended with more crushing or pulverization of the more compact bone at the wound of entrance, and with a greater breaking into small pieces of the loose splinters.

The differences observed in the two series of experiments are easily explained, the authors say. In firing with equal velocities, the weight and size of the Lebel bullet accounts for the less severe kind of lesions; but, at equal distances, this deficiency of weight and diameter is compensated for by the increase of velocity.

MM. Delorme's and Chavasse's Conclusions.

The writers of the paper, in their conclusions, say that the new projectile (the Lebel), owing to its increased velocity, possesses a greater power of penetration. It, in common with the Gras rifle bullet, at short distances produces explosive effects; between 300 and 800 metres the differences in effect are only of a slight character; both inflict very severe wounds; at 800 to 1,200 metres, owing to its small size and regular shape, it does not cause such severe injuries on bones as the leaden bullet of 11 mm., which so readily undergoes changes of shape, but thereby loses some of its force. Beyond 1,200 metres the bullet of the Lebel causes more comminution in the fractures it produces than that of the Gras rifle.

On the epiphyses and short bones, fractures and perforations of the same type and character are made by both bullets, but the smaller one causes generally less extended and less widely separated fissures,

the splinters from it are smaller and less broken up, and simple perforations are more often met with. In short, the wounds of joints by the Lebel rifle bullet are in general less comminuted and less severe.

If the envelope of the Lebel bullet broke, lead and possibly the deformed and empty case will be retained in the track.

Both bullets often carried in with them pieces of clothing.

Professors Chauvel and Nimier, of the Val de Grace, who have also made many experiments, do not altogether agree with the above conclusions, and are not inclined to give the Lebel rifle credit for more than an increased range with a consequent increase of penetrative power, which is in part due to the hard envelope, which does not usually undergo any change of shape.

Results of Experiments in this Country.

In some experiments carried out in this country with the Magazine rifle, a series of shots with the Metford bullet 0·303 were fired at the carcasses of horses at short ranges, viz., 100 yards. In all these instances, the so-called explosive effects upon tissues, whether hard or soft, were most marked, the bones were frightfully shattered, and the splinters and particles of bone were scattered far and wide in amongst the surrounding pulped muscles. In several instances, the envelope of the bullet had yielded when striking some hard resisting part of bone; the lead had then escaped, leaving an empty doubled-up case in the track. In such a case crushed bone and particles of lead were found in the pulped muscle. Unfortunately, no experiments were made at longer ranges. At the distance, however, of 100 yards hard compact bone was split into pieces, joint ends of bone were completely smashed, and such injuries were inflicted as would have been of the gravest character. Since these experiments were made, the cupronickel envelope of the bullet has been strengthened, and is consequently less liable to yield; the charge used was the ordinary service charge of compressed powder, and, in some instances, cordite or smokeless powder.

Conclusion.

In estimating the power of such rifles on the human body for purposes of warfare I do not think the wild game theory quite comparable. The sportsman's object is to bag his game; hence, in dealing with fierce animals, he must so stun them, if they are not killed outright, that they cannot offer any more resistance; again, in the case of deer, &c., it is well known that breaking the leg only is tantamount to losing the animal, unless a second shot is more successful. In fighting with Western nations there is very little fight left in a man once wounded by a rifle bullet; other reasons come into play; though there may be but little shock, the tendency of men when hit

is to fall out. Against some Eastern nations, especially when fanaticism exists, doubtless a stopping power is a desideratum.

It seems to me that some other lessons are to be learnt from the so-called Aldershot case referred to at length in the paper published in the November number of the United Service Institution Journal. The man was hit at a distance of 1 mile behind the 800 yards range, or at a range of 2,500 yards, by a bullet which, after encountering two ricochets and traversing 2,500 yards, had still sufficient energy to go right through the thick of a man's thigh, and bury itself afterwards in the ground.

If one may be allowed to conjecture, it is only fair to say that supposing the bullet had struck his chest or abdomen, it would have penetrated, if not perforated, these cavities, and so probably have caused the man's death; or, again, if the bullet had struck a joint, it would undoubtedly have split the bones forming it. At this distance of 2,500 yards would the Martini-Henry rifle have been able to touch him, and, if so, could it have caused more harm than a slight contusion without any breach of surface? Yet this small bullet, 0·303, not only hit the man but perforated his thigh, and, as the chance was, it merely created a slight flesh wound, whereas, if it had struck him in a vital part, it was quite capable of causing his death, or some serious injury to bone or joint that would have been the cause of a lengthened illness.

My object, however, is not to criticize, but to bring forward some experimental results, which, in my opinion, go far to prove that not only will a greater number of wounded fill our hospitals in the future, but that the character of the wounds produced by these small enveloped bullets are likely to be of a nature that will try the Surgeon to the utmost, and will not be conducive to the soldier's speedy return to a military life.

FOREIGN SECTION.

THIS portion of the Number, hitherto the Occasional Notes, has now become the Foreign Section, and is reserved for articles, either original or compiled, on professional subjects connected with Foreign Naval and Military matters; also for notices of Professional Books, either Foreign or English.

The Council of the Institution wish that this section shall be developed still further, and I have undertaken to continue my Editorship during the current year, with a view of aiding them in carrying out this work. It seems to me possible to make this section, and consequently the Journal, the means of keeping our Members acquainted with all naval and military progress abroad *pari passu* with that progress; and I shall be glad to receive from members of both Services, including in the latter those of the Auxiliary Forces, suggestions, information, or offers of assistance.

It is desirable, further, that I should state that, as regards editing the Naval matter in the Section, I shall have the aid of Naval Officers, thoroughly competent to give good advice and to pronounce sound opinions.

It must, however, be borne in mind that, as the change from a quarterly to a monthly issue has been made in order to ensure the more prompt publication of the Lectures after their delivery than has hitherto been the case, the Foreign Section will, as a rule, be restricted in extent during the Lecture season in the first half of the year, and will be prominent in the second half.

It is requested that communications and books for review (the latter under cover to the Librarian) may be addressed to me at the Royal United Service Institution, Whitehall Yard, London, S.W.

LONSDALE HALE,
Colonel R.E. ret.

THE NAVAL SCHOOLS OF THE CHIEF CONTINENTAL POWERS. PART III.

(*Continued from No.* 168.)

Compiled by Major W. TENISON, the Manchester Regiment, from papers in the "Rivista Marittima," by 1st Class Commissary DANTE PARENTI.

Russia.

THE Russian Naval School is established at St. Petersburg, on the Vassili Ostrof, in a large building capable of accommodating from 500 to 600 students. The Staff consists of an Admiral as Commandant, a Director of Studies, a Director of Exercises, 5 company Officers, 12 Officers (Professors), 60 non-commissioned officers, and 130 civilians (Instructors and employés).

The course of studies lasts over four years, the first of which devoted to a preparatory course, the remaining three to scientific and naval instruction, with a yearly practical course on board ship, from June to September.

The students are divided into two sections and six sub-sections.

The finances of the School are confided to a Council of Administration, composed of the Director of Studies, the Chaplain, and the Professors. This Council of Administration has also charge of all matters relating to the organization of the studies, the instruction, and the time tables and programmes of work to be carried out.

Conditions of Admission.—The right of admission to the Naval School may be obtained by—

1. The sons of hereditary nobles.
2. The sons of superior Officers.
3. The sons of hereditary notables (a title which may be conferred by the Emperor on certain burgesses, who for ten years have rendered signal or meritorious services to the State).

In Class 2 a candidate must furnish proof of having been born after the promotion of the father to the rank of superior Officer. Exception, however, to this rule is made in the case of a candidate whose father may have obtained by his ulterior promotion the right to rank as hereditary notable.

The candidates must be over twelve years of age on the 1st September of the year of admission, and under fourteen years, and must show a natural aptitude for the naval service. They must undergo a medical examination, before a Board of Officers nominated by the Admiralty, who take particular notice of those defects which would debar them from service. Any disease which may show itself after

the admission of a candidate will cause his instant dismissal from the School. The candidates' sight is tested by the Snellen-Reich scale; letters and signs 23 millimetres high must be read distinctly and without effort at a distance of 20 feet; and as to colour blindness by the Holmgren system.

Parents or guardians desirous of obtaining admission to the School for their sons or wards who have not yet attained the limit of age must send in their claim not later than the 15th July, together with a certificate of baptism, duly attested by competent authority.

In the case of students at Government establishments, a declaration from the Director of the Institute will be sufficient, in lieu of a baptismal certificate. If the claim is made by a guardian, a legalized copy of the right of tutelage must be attached.

The Examinations.—Those authorized to present themselves at the entrance examination must attend at the Naval School at 10.30 A.M. daily on the 12th and 13th August, to undergo medical examination, if not previously so examined.

The examinations begin on the 16th August, and continue till the 26th August. The examinations are public. Those candidates who have been declared medically fit, and have passed successfully the examination, are admitted into the preparatory class.

The first twenty-four are admitted at the cost of the State. The next seven must defray the cost of their maintenance, but have a claim to certain scholarships, which, however, they may forego in favour of others. These scholarships have been founded at the Naval School by the liberality of individuals and recognized bodies, after whom they are called.

The privilege of admission at the cost of the State is granted in the first instance to the sons of hereditary nobles who have given proof of the required ability; next in classification follow the sons of superior Officers; and lastly, the sons of hereditary notables.

In order to obtain one of the above-named scholarships, a candidate must have passed the entrance examination, and been classified as "good."

In classifying the sons of superior Officers, the following gradation is observed:—

1. Sons of Officers who are serving, or have served, in the Navy.
2. Sons of Officers who are serving or have served in naval establishments; sons of Doctors attached to naval establishments; grandsons of naval Officers.
3. Sons of Officers attached to the Admiralty and other establishments dependent on the Navy, and grandsons of Officers and Doctors attached to these establishments.
4. Sons of other functionaries who have a legal claim to admission to the Naval School.

In the case of either maternal or paternal grandsons of naval Officers, and of Officers and Doctors attached to naval establishments, in addition to the certificates of birth, there must be attached to the claim for admission another certificate proving the parentage, and, if necessary, the certificate of birth of the parents, and the declaration of nobility

obtained from the provincial authority in whose jurisdiction they are domiciled.

Those candidates who have failed to pass the examination, or who, having passed, are unable to enter the School through inability to do so at the expense of the State (all such places being already filled up by candidates having prior claims to this privilege), may present themselves for re-examination the following year, provided they have not passed the limit of age.

All documents of those candidates who are not admitted are returned on application.

The subjects for the entrance examination are:—

The Catechism and Religion, Russian, Geography, Russian History, Mathematics, and French.

The maximum of marks is 12, according to which the general classification is made. All are rejected who fail to obtain—

a. 8 marks in oral examination in Religion and Mathematics, or in the written solution of mathematical problems.

b. 6 marks in oral examination in Russian.

c. 5 marks in oral examination in History, Geography, and French.

The parent or guardian of every candidate claiming admission to the Naval School must send in to the Chancellery of the School, together with the application for admission, a document acknowledging formally his obligation to meet all the expenses of the candidate's maintenance in the event of his failing to obtain gratuitous maintenance or some special scholarship. This amounts annually to 530 roubles.

The yearly accounts of the paying students, and of those who hold a scholarship, are submitted for examination to the Ministry of Marine, and the sums due must be paid into the Public Treasury, the receipt being in due course sent to the School.

The uniform is provided by the School.

Those students for whom the sums due for maintenance have not been received at the appointed time, are dismissed from the School.

The sums paid for the maintenance of paying pupils can in no case be refunded.

The holders of scholarships and the paying students are in every way on an equal footing as those admitted at the expense of the State.

The holders of scholarships retain their scholarship during the whole of their sojourn at the School; the others pay only so long as they remain in the two preparatory classes.

The Studies.—The following are the subjects of study at the Naval School:—

Religion, Russian, French, English, Drawing, Natural History, History, Geography, Arithmetic, Algebra, Geometry, Geometrical Drawing, Statistics, Plane and Spherical Trigonometry, Integral Calculus, Descriptive Geometry, Mechanics, Physics, Chemistry, Physical Geography, Navigation, Pilotage, Astronomy, Theory of the Deviation of the Compass, Hydrographical Drawing,

Naval Construction, Naval Architecture, Steam Engines, Naval Artillery, Fortification, Submarine Defences, Law, Naval History, and Figure and Landscape Drawing (voluntary).

No pupil may remain in one class more than two years.

Each School year commences on the 15th September, and terminates on the 25th May. The summer months are spent on board one of the ships of the squadron of instruction.

Cadets are promoted to Midshipmen after passing the prescribed examination, provided they have passed twenty-four months on board ship.

Other Schools.

School of Navigation and Artillery, at Kronstadt.—No special conditions as to birth are necessary for admission. A candidate need only pass the necessary examination. The object of the School is the education of Master Gunners, Pilots, and Engineers.

The ages of admission are—

For the Artillery section, 13 to 17. For the Navigation, Construction, and Engineering section, 15 to 18.

At the end of the course the students, if they have passed the examinations successfully, are nominated probationers, and two years later, if they again pass the prescribed examination, obtain the effective rank of Officer.

A School of Artillery is annually established on one or more ships.

Torpedo Schools.—At Kronstadt, for Officers. Duration of course, eighteen months. Subjects of instruction, Physics, Chemistry, Explosives, Telegraphy, &c.

At St. Petersburg and Odessa, for non-commissioned officers, corporals, and seamen.

School of Musketry.—For Officers and non-commissioned officers. Subjects of instruction: Musketry, Fencing, and Gymnastics. The course lasts one year.

Superior Naval Academy.—At St. Petersburg, in the same building as the Naval School, for the higher education of naval Officers. The admission is by competitive examination. The course lasts two years, and the subjects of instruction are:—

Higher Mathematics, Mechanics, Steam Engines, Chemistry, Hydrography, Astronomy, Physics, Law, International Law, Tactics, Naval Construction.

There are special courses for Naval Constructors, Engineers, and Hydrographers.

Those Officers who have passed successfully the final examination wear a distinctive badge on the arm, consisting of two oak branches encircling the imperial cipher, and reap great professional advantages.

Spain.

The Spanish Naval School is established at Ferrol on the frigate "Asturia." The Minister of Marine, as chief of all naval corps,

institutions, and establishments, is Inspector of the School, and the General Commanding the Department is Sub-Inspector. The Staff consists of:—

A Post-Captain as Commandant and Director,
A Captain as Second in Command and Sub-Director,
A Commander as Third in Command,
14 Lieutenants as Professors,
6 Lieutenants as Duty Officers,
An Administrative Official,
Three Medical Officers, and
A Chaplain.

The Instructors of modern languages, drawing, gymnastics, and fencing may be civilians, engaged under special contract, in the event of a dearth of Officers of the various corps capable of imparting such instruction.

The servants of the establishment and students' bâtmen are partly soldiers, partly civilians, as may be most advantageous.

Admission to the School.—The following are the necessary conditions for admission to the School:—

1. Application must be made direct to the authority named in the published notice of a forthcoming competition. To the application must be attached a baptismal certificate duly attested, testifying that the candidate is over 13 and under 18 years of age.

2. The candidate must be a Spanish subject.

3. He must be healthy and of good physique, as certified by a Medical Board composed of three naval Medical Officers, under the presidency of a Superior Medical Officer.

4. He must pass successfully an entrance examination in the following subjects, viz.:—

English or German, French, Drawing, Arithmetic, Algebra, Plane and Spherical Trigonometry.

5. He must furnish to the Board of Examination a certificate obtained from an accredited school, testifying to his knowledge of geography, and Spanish history and grammar.

The Board of Examination consists of—

A Post-Captain as President.
A Captain, or Commander, as Vice-President.
3 Lieutenants (2 of whom must be Professors at the Naval School) as members, and 1 Lieutenant as supernumerary member.

The Board record their opinion of the merit or demerit of the candidates by the following marks:—

7 Excellent, 6 and 5 very good, 4 and 3 good, 2 and 1 satisfactory, 0 unsatisfactory.

In order to obtain the total marks for each candidate, the foregoing marks are multiplied by the following coefficients:—

Drawing 1, English or German 1, French, Arithmetic, Algebra, Geometry, and Trigonometry 2.

The entrance examinations are public, but the record of the marks obtained is not published.

Sixteen students are admitted yearly.

Candidates after admission may, within the first fifteen days of their sojourn at the School, pass the first and second bi-yearly examinations, thus proving their complete knowledge of the required subjects, provided, however, that they pay the amounts due for the time that they have succeeded in saving thereby.

The following are the daily payments due for each candidate, and which may be paid either in one sum or quarterly in advance.

For sons of naval and military Officers, 2 pesetas per diem.

For all others, 3 pesetas per diem.

(1 Peseta = 1 franc.)

By a special law, passed 8th July, 1860, sons of Officers killed on active service are admitted at the expense of the State; and of these six are admitted annually, provided they obtain the requisite number of marks in the examination.

Officers' orphans are admitted at the reduced rate of 1 peseta per diem; the number not to exceed 15 in the School at one time. Those entitled to this privilege must send in their claim in due time.

Every candidate not eligible for gratuitous admission, or admission at reduced rate, must bring with him his outfit according to established scale, and all charges for uniform, &c., and for repairs and renewal thereof, must be borne by the candidate's parents, as well as all loss and damage of School property. These charges for uniform, &c., amount to 1,250 pesetas, which may be paid half on admission and half at the beginning of the second year.

Officers' orphans who have obtained gratuitous admission pay nothing, and are not required to furnish any outfit, provided they establish their claim 15 days before admission.

The School receives 1,350 pesetas from the Admiralty for each pupil admitted gratuitously, to cover all expenses incurred during his sojourn, and at the termination of the course, if promoted to Naval Cadet; and 250 pesetas for each half year spent in preparation for further promotion.

The Minister of Marine, as Inspector of the School, is Commandant-in-Chief. The General Commanding the Department wherein the School-ship may be anchored must, in his capacity of Sub-Inspector, visit and inspect it from time to time (making any proposition he may think necessary to the Inspector), and, when convenient, preside over the Board of Examination.

The Commandant of the ship is Director of Studies, and responsible for the moral, scientific, and naval education of the Cadets. He holds his appointment for four years, and has to send a monthly report on the discipline and administrative regulation of the School to the Commandant of the Department, and reports from time to time as to the capabilities and conduct of the Professors.

The Second in Command also holds his appointment for four years. He discharges the duties of Commandant during the latter's absence, and has charge of all school instruments, books, &c. He sends in a

written report at the beginning of each month to the Commandant on the progress and conduct of the students, and to their respective families on their conduct, punishments, and health. All punishments inflicted, and marks awarded, are entered by him in a register kept for that purpose. He publishes the orders issued by the Commandant.

The Third in Command takes the place of the Second in Command during his absence, and is a member of the Board of Administration and of the Council of Discipline. He holds his appointment for three years. He has under his special charge those students who are attending the School with a view to passing for promotion to Sub-Lieutenant.

Six Lieutenants are attached to the School as duty Officers. Of these two come on duty daily, one acting as Officer of the watch, in charge of the ship and the personnel attached to the ship, the other in charge of the students, as well during the hours of relaxation as during the studies. Both Officers on duty must attend all meals, and during the night they relieve each other at stated intervals.

The Professors have each charge of some particular branch of study. They send in a monthly report on the progress made by the students to the Sub-Director. They do not sleep on board the ship, except in case of necessity, but must report themselves half an hour before the commencement of the studies, and must not leave the ship till the evening. After three years as Professors they become eligible for the Naval Cross for Merit, with a distinctive badge corresponding to the rank they hold. A prize is given for any original work, of sufficient merit, which may facilitate the instruction of the students, 500 copies of which are published at the expense of the School.

The Chaplain must be a man of high literary and moral attainments; he has charge of the religious training of the students, and visits the sick daily.

The duties of the Administrative Officer are the same as those of the Paymaster on board a man-of-war. He holds his appointment for four years. At the end of each quarter he sends to the students' parents an account of all expenses incurred on their behalf, and reports in writing to the Director in the event of payment not being punctually made. He is a member and Secretary of the Board of Administration.

The duties of the Medical Officers are the same on the School-ship as on any other man-of-war.

No student may leave the School-ship except with the approval of the Minister, and with the permission of the Council of Discipline.

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The principal duties of the students are:—

1. Absolute obedience and respect to their superiors, the Officers of the School, and all naval authorities.

2. Love of the profession they have voluntarily chosen, and to which they propose to belong.

3. Obligation to maintain and uphold at all cost the honour and reputation of the service to which they belong, and to conduct themselves always in an exemplary manner.

They must habituate themselves to keep always clean and neat all books, instruments, and articles of clothing, and to comport themselves decorously.

They are not allowed to possess or wear any article of jewellery, with the sole exception of a silver watch with a black guard.

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(To be continued.)

NOTICES OF BOOKS.

Hastings and the Rohilla War. By Sir JOHN STRACHEY. Oxford: Clarendon Press, 1892. Pp. 324. Size 9″ × 5″ × 1″. Weight under 1 lb. 10 ozs. Price 10*s.* 6*d.*

Directly this book is the clearing from baseless calumnies the posthumous reputation of one of the greatest of those men the hardihood and endurance of whom, says Sir Alfred Lyall, which won for England an Empire, were equalled only by the general justice and patience with which they pacified and administered it; and the author has, in doing this, wiped away what Macaulay characterized as a "lasting stain on the fame of England." The doubtfulness of the accuracy of Macaulay as a historian is generally admitted; Burke, the bitterest and most eloquent of opponents, is not much read by the rising generation; but James Mill still holds the position as the authoritative writer of Indian history. Of Mill, Sir J. Stephen writes, "His want of accuracy is nothing to his bad faith." Everyone who has read or intends to read Mill to learn about India should carefully first peruse this ably-written and interesting work from the pen of Sir John Strachey.

Imperial Defence. By Sir C. DILKE, Bart., and SPENSER WILKINSON. London: Macmillan and Co., 1892. Pp. 234. Size 7½″ × 5¼″ × 1″. Weight under 1¼ lbs. Price 3*s.* 6*d.*

In the Introduction the authors point out the necessity of the British Empire being prepared for war; they then turn to the primacy of the Navy and the command of the sea; and so far probably there will not be much dissent from the general views they hold. In the two following chapters the debatable subjects, the Peace of India and the North-West Frontier, are taken in hand, and we gather that for the defence of India two army corps from England will be required when the decisive moment arrives. How these are to be furnished comes under the heading "The Armies," which include one entirely under the control of the Indian Government, which would arrange its own service on the basis of an enlistment for a long term of service followed by pension or money gift, and a Home Army able to put into the field 7½ army corps; all Colonial stations being handed over to the Marines. By this latter expedient the naval bases, the ships for which they exist and which have to protect them, and the garrisons of their forts, will then, it is claimed, have the advantage of being under the undivided command and administration of a single authority—the Admiralty. Until the scheme is fully carried out, the Militia and Volunteers are to be formed into army corps of their own, comprising all the necessary arms, and every auxiliary service, such as transport and commissariat.

The authors appear to be much annoyed at a fact they seem to think they have discovered, namely (p. 180), that the "British Army at home has no Generals," and they add, it "can have none until its battalions are settled and grouped into brigades, divisions, and army corps." Good times are at hand for our Colonels if only our two military advisers have their will, for they say: "In the absence of Generals there is no guarantee that even the elementary work, the training and handling of battalions, is conducted on principles calculated to ensure their fitness as component parts of an army." Further, in order to teach the Generals, change of quarters at home is to be put an end to, and (p. 144) every battalion, battery, and squadron will have a permanent home, and so can be formed permanent

brigades, divisions, and army corps. When Sir Charles Dilke and Mr. Spenser Wilkinson have worked out their schemes in detail, as military men would have to do before carrying them out, and have submitted them to public criticism, then will be the time to consider the working value of proposals now put forward in the crudest form only.—L. A. H.

Journal of the United States Artillery. Published by the authority of the Staff of the Artillery School. Artillery School Press, Fort Monroe, Virginia. Pamph. Pp. 80.

This is the first number of a new Service publication on the other side of the Atlantic. We wish it every success.

Britannic Confederation. A Series of Papers by Admiral Sir J. Colomb, Professor E. A. Freeman, George G. Chisholm, Professor Shield Nicholson, Maurice H. Hervey, and Lord Thring. Edited, with an Introduction, by A. SILVA WHITE. London: Philip and Son, 1892. Pp. 180. Size 7¾″ × 5½″ × 1″. Weight under 1 lb. Price 3*s.* 6*d.*

This is a series of papers originally published in the "Scottish Geographical Magazine," and they are now re-issued in book form in order to meet the demand for a wider circulation. There are no dogmatic conclusions to be drawn from the volume, for, as Mr. White tells us in the Introduction, "At present we are only groping in the dark towards the attainment of an ideal on which history sheds little or no light." Sir J. Colomb gives "A Survey of Existing Conditions;" Professor Freeman deals with "The Physical and Political Bases of National Unity;" Mr. Chisholm with "The Commerce of the British Empire;" Professor Nicholson writes of "Tariffs and International Commerce;" Mr. Hervey considers, under "Alternative Measures," race union and race disintegration; whilst, finally, Lord Thring treats of the "Consolidation of the British Empire." The book is a mind-opening contribution to the whole question.

Nicknames and Traditions in the Army. London: Gale and Polden. Pamph. Pp. 117. Price 1*s.* post free.

The Advanced Class-book of Modern Geography; Physical, Political, Commercial. By W. HUGHES and J. FRANCON WILLIAMS. London: Philip and Son, 1892. Pp. 818. Size 7½″ × 5½″ × 1¾″. Weight under 2 lbs. 2 ozs. Price 3*s.* 6*d.*

A useful book of reference.

La Russie et l'Invasion de l'Inde. Par PIERRE LEHAUTCOURT. Paris: Charles Lavauzelle, 1892. Pamph. Pp. 21.

This is a very brief summary arrived at from a French point of view. The writer indicates Herat-Candahar as the most probable line of invasion, and Candahar-Ghazni-Cabul as the line of defence; he considers that the enterprise would be very difficult of execution, and regards any prophecy as to the final result impossible; at the same time he seems to think the simultaneous defence of India and of the rest of the British Empire a crushing task to have to perform.

Notes on Fortification. By Lt.-Col. FOX IRWIN. Jersey: Le Feuvre, 1892. Pp. 98. Size 9½″ × 7½″ × ½″. Weight under 1 lb. 2 ozs. Price 3*s.* 6*d.*

This book is one of printed notes on the subject it deals with; it contains references to the text-books, and is interleaved so that students may draw opposite to a note the figure referred to in connection with it.

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